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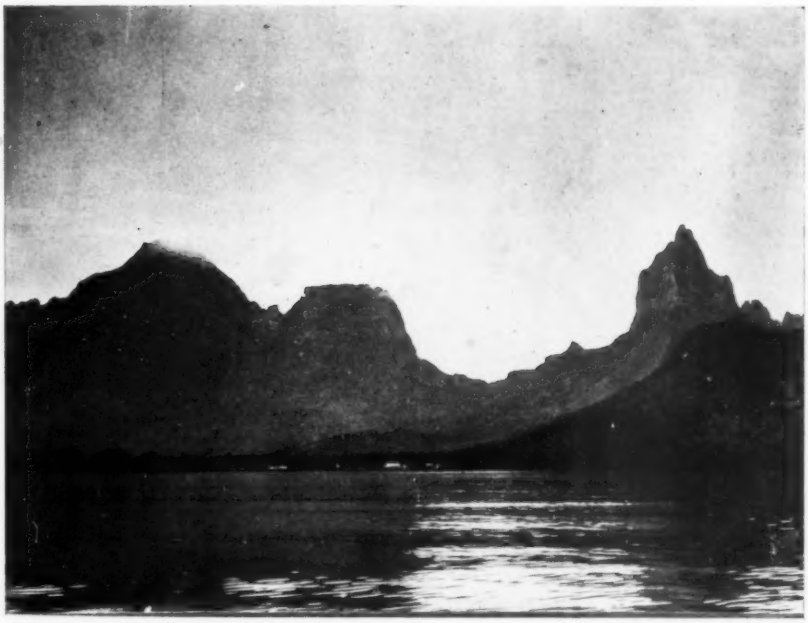

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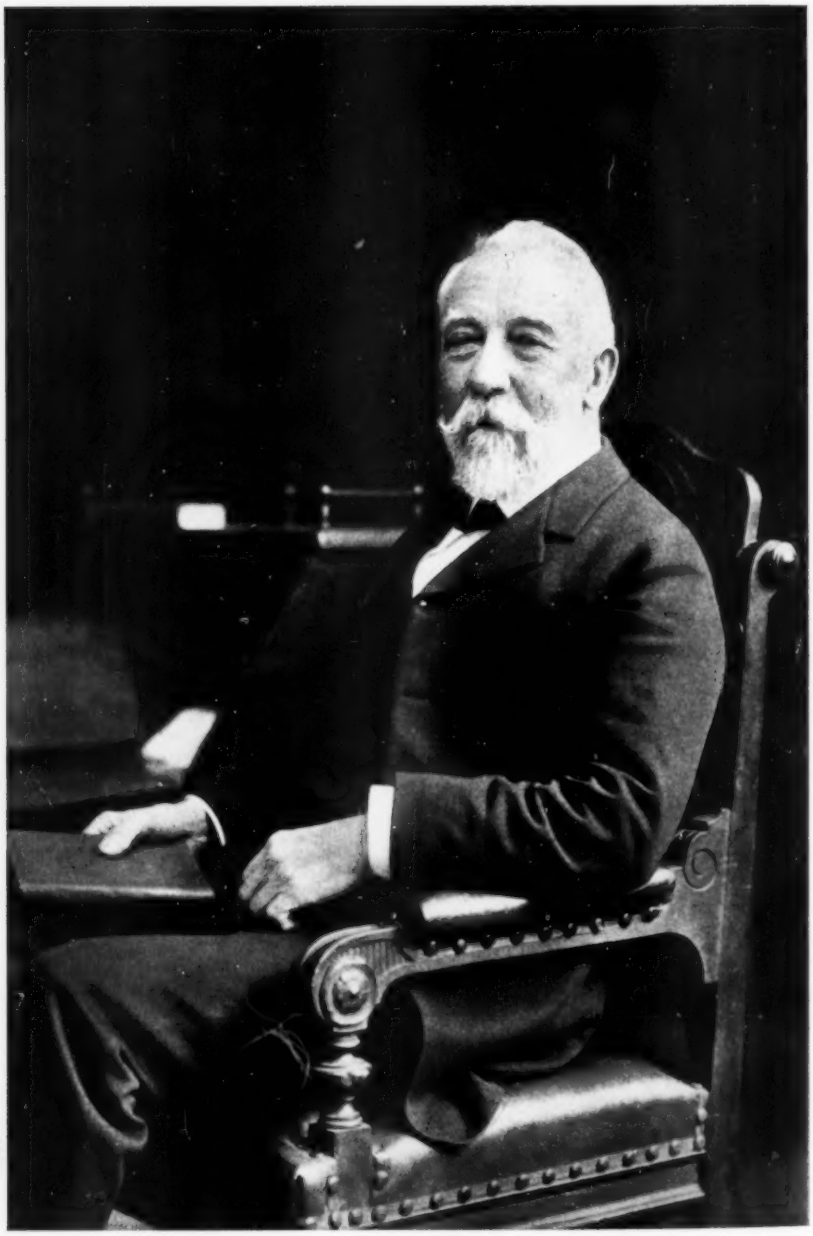


ROBERT PARR WHITFIELD

Curator of Geology and Invertebrate Palæontology, 1877–1909

The American Museum Journal

Vol. X MAY, 1910 No. 5

ROBERT PARR WHITFIELD

ROBERT PARR WHITFIELD, Curator Emeritus of Geology and Invertebrate Palæontology, died on April 6 after a long illness. Coming to the Museum while still in the prime of life, he rendered most faithful service to the institution for thirty-three years and did his full share in placing it in its commanding position in the scientific world.

He was born at New Hartford, Oneida County, New York, May 27, 1828, and therefore came from a region which has furnished several of the most famous geologists and palæontologists of America. At the age of nine, the boy began work in a cotton mill, later entering the shop of his father, who was a spindle maker. When he was twenty, his father gave young Whitfield his time, and he was employed by Samuel Chubbock, a well-known manufacturer of philosophical instruments at Utica.. His spare moments were spent in collecting the fossils for which the region around that city is famous and in preparing, mounting and studying them, his interest in natural history having been aroused and fostered in very early life by an English nurse who was in the family. School education did not fall to his lot; in fact, as he has stated in conversation with the writer, his entire school training amounted to less than three months of time in all, and he never saw the inside of a school house as a student after he was twelve years old. Hence Professor Whitfield's career as a scientist is even more remarkable than it would have been, if he had had the advantage in early life of the scholastic and other training that has fallen to the lot of the majority of men who have attained eminence in science.

In the early fifties, Professor James Hall heard of young Whitfield's collection, visited him and saw the scientific promise in the young mechanic. When, therefore, poor health obliged him to give up his work in the shop in 1856, Professor Hall was glad to get his assistance on the Natural History Survey of the State, and Mr. Whitfield removed to Albany, where he remained as an assistant in palæontology and geology

for more than twenty years. When the great James Hall Collection of fossils was purchased for the American Museum, the services of Professor Whitfield were secured for its care, and he entered upon his duties as Curator of Geology in January, 1877, being the only curator that the institution then had. His first year was devoted to arranging the geological and palæontological material in the exhibition hall assigned to it in the new building of the Museum, and when this building, which is now known as the North Wing, was opened to the public, December 22, 1877, the collections in his charge were by far the most important from a scientific standpoint among all the possessions of the Museum.

Throughout his whole career, the mechanical skill developed in the tool and instrument shops stood Professor Whitfield in good stead, and it was of material assistance to him in the development of his talents as a draftsman. His first efforts at making drawings for publication were in the delineation for the State Survey of the correct relations of the complicated remains of fossil crinoids, or sea lilies. He soon surpassed the other draftsmen in the accuracy of his observations and in the skill and brilliancy with which he used his pencil in representing fossil forms, and it was not long before he became the head draftsman of the Survey. In this capacity he executed several thousands of drawings before the termination of his connection with the organization. This training as a draftsman was of material assistance to Professor Whitfield in all his studies. His recognition of old and new features amounted almost to an instinct, and there is little question that for nearly half a century he had no superior in this country in the identification of fragmentary invertebrate fossils.

In addition to his work for the State of New York and this Museum, he studied and described the fossils which were gathered by the Clarence King Geological Survey of the Fortieth Parallel, Jenney's and Ludlow's expeditions to the Black Hills of South Dakota and much of the material gathered for the geological surveys of Ohio, Indiana, Wisconsin and New Jersey.

Soon after he came to the Museum, he began to urge the establishment of a medium for the publication of the results of the scientific work done in the Museum. This led to the institution, in 1881, by President Morris K. Jesup, of the Museum "Bulletin," the first five articles of which, comprising all that was issued during the first year of its existence,

were prepared by Professor Whitfield. In the succeeding years, he contributed many articles to the pages of the "Bulletin," and the last piece of work that he did in connection with his department was the preparation, during the latter half of last year, of the text and drawings of the descriptions of several new species of fossil shells from the Mt. Lebanon district of Syria. The drawings, to be sure, show the effects of advancing age and infirmity, but nevertheless they indicate clearly the master hand that prepared so many thousands of antecedent figures.

Although never a man of strong physique, Professor Whitfield usually enjoyed good health and was able to accomplish an immense amount of work. The Hall Collection of fossils was his idol, and its care and interests were constantly on his mind. Naturally methodical and systematic himself, the arrangement of the collection reflected these characteristics of the man and was the joy of the visiting scientist who desired to inspect a particular species with or without the assistance of the curator. Almost punctilious in his attention to duty and to his ideas of Museum work, he was always to be found either in the exhibition hall or in the laboratory, never going away on collecting expeditions except within the limits of his usual brief vacations. Remaining actively engaged in his department to within so short a period of his demise, his removal means much to the Museum and his familiar figure and his counsel will be greatly missed.

EDMUND OTIS HOVEY.

THE DODGE EXPEDITION TO MISSISSIPPI

THE Museum collection of fishes is poor in "ganoids"—sturgeon, gar-pikes, amia, shovel-noses and spoon-billed catfish or paddle-fish—and it has seemed desirable that this ancient group should be exhibited adequately in the Hall of Fishes. One reason for the interest in "ganoids" is that they are known to be the race of fishes from which all the modern types such as perch, cod and salmon are descended. Accordingly, thanks to the aid of the Dodge Fund, an expedition was sent in March to spend several weeks in a region which is peculiarly rich in these rare forms for the purpose of obtaining material to show their structure and development. In the northwestern corner

of the state of Mississippi there is an extensive fishery of the paddlefish (*Polyodon folium*) which is in charge of Mr. J. E. McGehee, a friend of the Museum, who put at its service his launches, fishermen and nets. There was thus offered an unusual opportunity for securing the desired collection, which was further improved by the fact that during the present spring a lake, Moon Lake, was to be fished, which had not been netted before. The collecting party consisted of Dr. L. Hussakof and Mr. Dwight Franklin. They report excellent success in collecting specimens and in obtaining casts and color studies which will ultimately be used in the preparation of habitat groups.

A FOURTH JOURNEY TO THE SOUTH SEAS

DURING the years 1906 to 1908, inclusive, I made three voyages to Tahiti and the other islands of the Society group, under the auspices of the American Museum and of the Carnegie Institution of Washington. The purpose was the investigation of the land-snails of these islands, and each year the results proved so unexpectedly satisfactory that further explorations were found desirable and were accordingly planned and carried out. My fourth journey, that of 1909, extended over about 15,000 miles of the Pacific Ocean and involved travels in seven groups of islands (the Society, Cook, New Zealand, Tongan, Samoan, Fijian and Hawaiian) while some of the Paumotus were seen in passing. My route is shown in the chart on page 125. The investigation of the land-snails of the Polynesian region was undertaken on account of the unusually favorable conditions for the study of certain evolutionary results and processes. Every biologist is familiar with Gulick's famous writings of the last quarter of the nineteenth century, in which he demonstrates that the Achatinellid land-snails of the Hawaiian Islands vary from valley to valley and from island to island of the group. As descendants of a common ancestral stock the different valley colonies and island types are the products of divergent evolution in correlation with their greater or lesser degrees of isolation. The efficiency of differing environmental conditions as actual factors in the process of species differentiation has been variously estimated by writers like Romanes, Jordan, Allen, Wallace and others, who have dealt with

PAPEETE AND THE NORTHWESTERN PART OF TAHITI

LOOKING SOUTH IN OPUNOHU BAY MOOREA SOCIETY ISLANDS

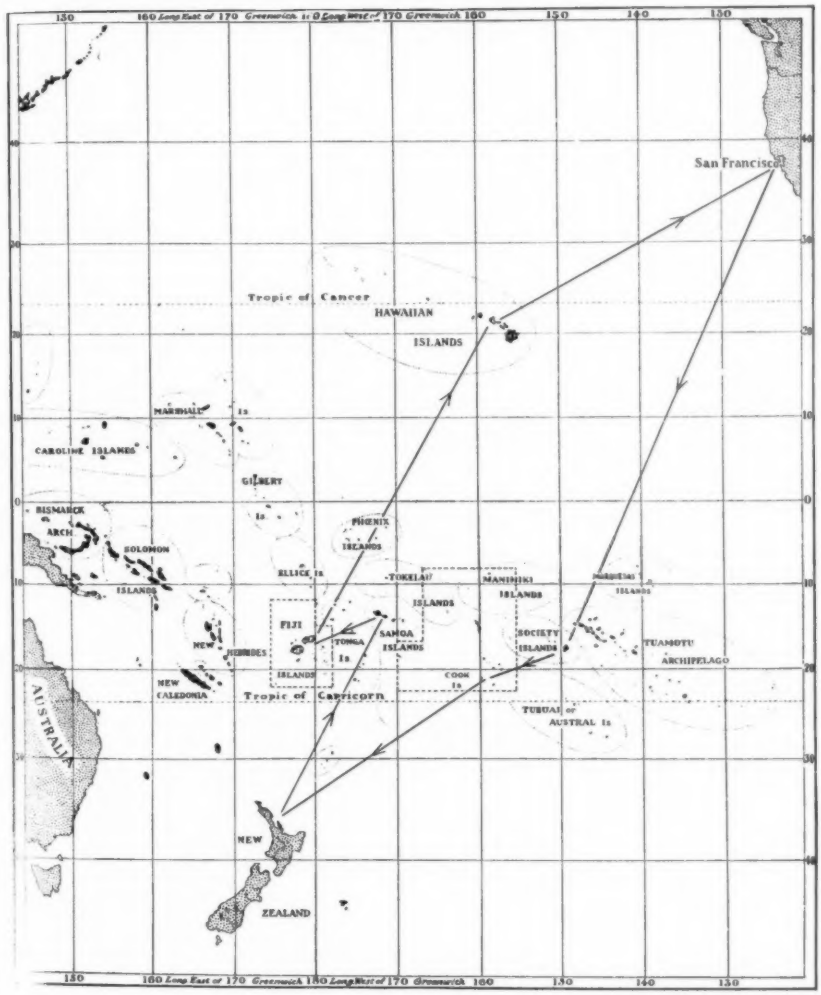
The impressive and strangely sculptured peaks are part of an ancient crater wall

similar phenomena displayed by other groups of organisms. Dr. A. G. Mayer made an initial biological study of the Tahiti land-snails belonging to the genus Partula and found remarkable differences between the valley colonies of this island. Advised by him to carry investigation further, I undertook the journeys mentioned, and the present brief account of the last one will give some of the general results of studies in the field and laboratory.

The first landing place as in previous voyages was the island of Tahiti, the largest and best known member of the Society Islands. Papeete is its main town, situated on the northwest coast, and like Suva in the Fiji group and Honolulu in the Hawaiian group, it is the governmental and commercial centre of the surrounding region of the South Seas. Its great prominence has been gained from Captain Cook's famous voyages in the eighteenth century and from the establishment here of the earliest missionary settlements in southeastern Polynesia. The town now has over 3,000 inhabitants, about three fourths of whom are natives. Cook's estimate of the population of the entire island made in 1768 was 240,000 whereas now there are less than 10,000 natives. Even if we allow for considerable exaggeration in his estimate there has obviously been a frightful mortality, resulting from their contact with white races and from the almost total destruction of their primitive scheme of life.

On approaching Tahiti, the island reveals itself as a magnificent double cone of ancient volcanic rock; the larger cone is twenty-five miles in diameter and rises to a height of nearly 8000 feet; it is joined by a low narrow isthmus to the smaller cone which is fifteen miles across. The view of the island near Papeete (page 123) shows also the characteristic mountain ridges whose central heights are covered by clouds from soon after sunrise to sunset. These ridges radiate with remarkable regularity from the interior to the sea, and the valleys between them are sometimes a half-mile in width, with dense tropical vegetation along the more level ground on either side of the streams. Sometimes the valleys are deep, narrow gorges with high, steep walls, bare of everything except low shrubs and grass. It is in the moist jungles of the valley bottoms that the Partulas live, and the higher and drier slopes form boundaries that restrain the snails from crossing to another valley, except during the wettest months of the rainy season.

More than two hundred valleys of smaller and larger size have been



ROUTE OF PROFESSOR CRAMPTON'S JOURNEY OF 1909

explored during my four journeys around and about the Society Islands. Over 100,000 specimens of snails have been obtained from Tahiti and the other five islands of the group — Moorea (see page 123), Raiatea, Tahaa, Huahine and Borabora. It was necessary to make a complete survey, in order that there might be no unknown gaps. On account of the high and rugged ridges which separate the valleys, it is very rarely possible to cross inland from one valley to another. It was my habit, therefore, to travel with my group of native assistants

TEVAITOA IN RAIATEA, ONE OF THE LEEWARD ISLANDS

A primitive village of the Society Islands

around the coast by canoe or whaleboat, or sometimes by carriage and on horseback, and to live literally among the natives in their primitive and interesting villages like the one shown on this page. Naturally it was possible to learn much of these people, their customs, their every day life and also their occasional ceremonies that the casual visitor to Papeete and similar large towns misses. A photograph is given on page 127 of one of their rare village fishing parties, undertaken in this case by the men of the entire district of Opoa in the Island of Raiatea.

The abundant collections in hand give a perfect demonstration o

the principles of geographical distribution. Each island possesses its own species, while its different valleys have forms that are usually markedly different. For instance, in the valley of Tipaerui of Tahiti the examples belonging to the species *Partula otaheitana* are almost all twisted to the right, and all of them are rather small, brown and streaked. Their relatives in the magnificent valley of Fautaua, a half mile distant, are larger, yellower and redder, but the fact of greater interest is that the shells of a large proportion of them twist to the left. In Hamuta

FISHING SCENE IN RAIATEA, SOCIETY ISLANDS

Distributing the fish caught for a district feast

Valley, just beyond Fautaua, the right-handed and left-handed members of the species are about equal in numbers, while in Pirai Valley beyond they are all left-handed. This last valley is the home of a small form, *Partula filosa*, that grows nowhere else in this island, in the group of islands or in the world.

When the collections are sorted out according to species and varieties and according to their geographical source, they give ample evidence to

prove that the divergent types of neighboring or distant valleys have arisen from common ancestors and that they have changed little by little, in one place and another, so as to become the distinct and characteristic types of their own neighborhoods. The evidence proves also that the snails have evolved primarily by "sporting," or mutation in the de Vries sense, and that the internal or constitutional factors are the potent ones, for the geological, climatic and general biological conditions are more uniform in these islands than anywhere else in the world. The

MANGAIA, ONE OF THE COOK ISLANDS

An uplifted coral limestone island

assignment of a secondary importance to environment is one of the principal results of my investigation.

A second result of equal importance is even more interesting. It is that the evolution of new types is taking place at the present time, as the evidence amply demonstrates in several instances discovered in different islands. My investigations give long-desired proof that the differentiation of species is going on under surroundings that are entirely natural

and not only under the artificial conditions of the laboratory and experiment station.

In June, July and the early part of August a final survey was made of certain baffling portions of Tahiti, Moorea, Raiatea and Huahine. I then passed on to the Cook Islands by a steamer which stopped long enough at Mangaia, Moki, Aitutaki and Rarotonga for a survey to be made of each place. With the exception of the last named, which is a "high" island like Tahiti, the Cook Islands are uplifted coral atolls

PAGOPAGO HARBOR, TUTUILA, SAMOAN ISLANDS

Showing part of the surrounding amphitheater of mountains

composed entirely of limestone. Mangaia, illustrated on page 128, is a typical example of such islands, which are relatively infrequent in the South Seas. These were originally low coral atolls scarcely rising above the surface of the ocean, and they were subsequently lifted by some geological power which raised the bottom of the ocean at this place, so that what were formerly the lagoons in the center became basin-like valleys. Earlier voyagers like Garrett and Cuming had reported certain species

of Partula from some of these islands, a remarkable fact in view of their low character and peculiar geological formation. Moki, however, had not been visited before. At both Moki and Mangaia, I found a species of Partula living in banana, orange and screw-pine (pandanus) groves of the coral plateau.

My voyage was then continued to New Zealand, which does not possess any species of Partula; but it is a region of great interest geologically on account of its volcanoes and geysers, and also in ethno-

VITI-LEVU, THE LARGEST OF THE FIJI ISLANDS

A characteristic jungle scene

logical respects because its natives, the Maoris, are the offspring of the same stock which peopled the Society, Cook, Samoan, Hawaiian and certain other groups of Polynesia. My route then proceeded through the Tonga group, which includes many beautiful examples of all three kinds of South Pacific islands. At the end of September headquarters were established in Apia, the main town of Upolu in the Samoan group, and explorations were made in this and neighboring islands. Peculiar species of Partula live here, and they, like the Society Island forms, are

restricted to particular islands. The climatic and other conditions were so adverse that a complete exploration was impossible in Samoa at this time of the year. In Tutuila, however, which is the largest island of American Samoa, a practically complete survey was made, and much interesting material was secured. The high mountain slopes covered with dense vegetation are pictured on page 129. They are like those of the Society Islands, but the intervening valleys are not as rigidly isolated as in the latter region, so that the species of different parts of the islands resemble one another quite closely. Our interest here centers in the comparison of Samoan species with those of other groups.

The Fiji Islands, next in order, belong ethnologically and geologically to Melanesia, a quite distinct region of the South Pacific. Ovalau and Viti-Levu were visited, but no species of Partula were found in them; the single form from this group that is known to science occurs in more remote islands. It seems strange to one familiar with southeastern Polynesia that the Partulas should be lacking, for the thick, moist jungle (page 130) and the topography seem to be in every way the same as in the eastern islands. Going next to the Hawaiian Islands, I spent considerable time in studying the famous collections in the Bishop Museum which were made by Andrew Garrett during decades of research in the islands of the Pacific. Most of the original forms had been discovered during Garrett's explorations, and so his collections with his own identifications must always have great value for the student of the present day. Through the kindness and courtesy of Dr. C. M. Cooke of the Bishop Museum, excursions were made into the field in the island of Oahu, in order to observe personally how the Achatinellid land-snails resemble and differ from the Partulas in biological relations. The remarkable fact resulting from this comparison is that the former snails are restricted to isolated trees or clumps of trees on the sides of the valleys, while the drier and more open valley-bottom forms the barriers, instead of the ridges as in the case of the Partulas. The essential principles of distribution, however, are the same.

The zoölogist who travels more or less extensively in the South Seas soon becomes an ardent student of the native inhabitants. His interests would be aroused by the primitive daily occupations and culture of the people who, nevertheless, have developed remarkable intellectual powers; but the feature of greater significance to the investigator of the principles of geographical distribution is the fact that precisely similar phenomena

are displayed by the various Polynesian island-races and lower forms like the snails already described. The Polynesians from the Paumotus westward to Tonga and New Zealand and from Hawaii southward to the Austral Islands possess the same general physical and intellectual characteristics, while their culture is practically uniform throughout this vast region. These resemblances indicate a common ancestry of the several races, and the native traditions confirm the conclusion which may be based solely upon observations of the present day. The islanders of each group have certain more or less unique qualities, especially in the matter of language. Subservient, like other living things to the control of evolution, the natives as well as the snails have come to differ more or less widely in correlation with their greater or lesser isolation in geographical respects.

HENRY E. CRAMPTON.

ANTHROPOLOGICAL WORK IN THE SOUTHWEST

DURING the past few months the Museum has been carrying on important anthropological work in the Southwest through Dr. Pliny E. Goddard and Dr. H. J. Spinden of the Department of Anthropology. A glimpse at what is being accomplished is given in a recent report from Curator Clark Wissler, who has been making a tour of inspection. Extracts from Dr. Wissler's report are as follows:

SANTA FÉ, NEW MEXICO,
March 30, 1910.

* * * * I am able to make a brief report on our work in the Southwest. In general, I find the results in collections beyond what I dared hope at the outset, while in the research side of the work my expectations have almost become realities. As you will recall, we planned work on a programme that would this year give us fair collections from the pueblo and non-pueblo dwelling Indians of New Mexico and Arizona, excepting the Zuñi and some divisions of the Yuma stock. To date we have collections from the four divisions of Apache peoples, two divisions of the Pima stock and the various Rio Grande Pueblo. Collecting among the Navajo is now under way, and I expect to try some of the Yuma groups soon. Thus, we shall have brought together in less than a year's time, from actual field-work, collections representing six tribal divisions and as many villages of Pueblo

Indians, as a whole constituting two general types of culture, occupying an area comprising the territories of New Mexico and Arizona. * * * *

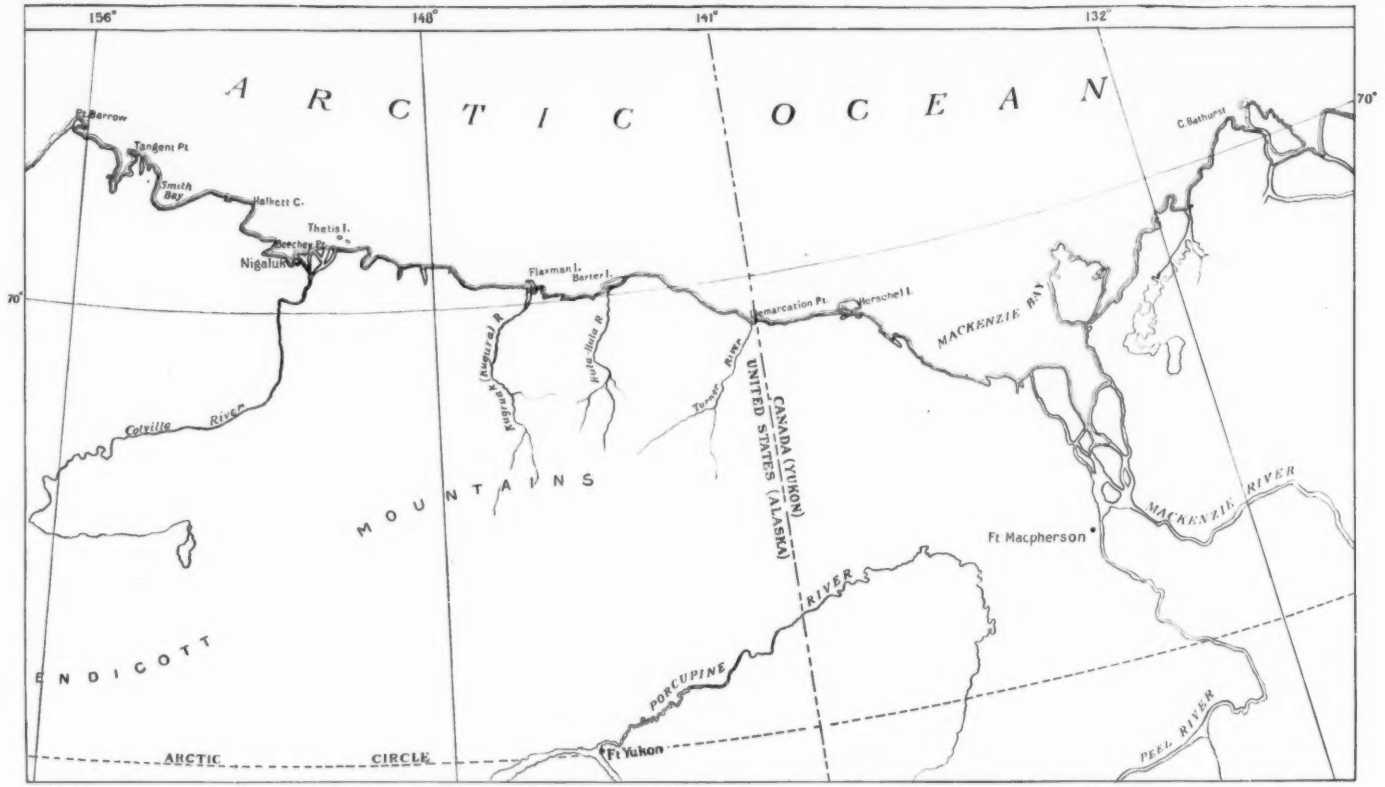
From the research point of view our important pieces of work are on the Apache and the Rio Grande Pueblo. The former resolve themselves into several groups each of which has a culture modified largely by environment and contact with their neighbors, the determination of these sub-types and their origins being the important problem. While the Apache hold a prominent place in the general literature of the South-west, their culture has not hitherto been made the subject of systematic investigation by anthropologists. * * * * The Rio Grande Pueblo constitute by far the largest body of their class, but they have not been systematically studied in contrast with the Zuñi and Hopi groups. While our collection is far from representative of the villages taken severally, as a whole it covers their general culture fairly well and contains some very good things. There are pieces of pottery made fifty years ago which in connection with that of recent make certainly give us the modern type, making our collection a standard. In several other classes of objects we fare almost as well.

STEFÁNSSON–ANDERSON ARCTIC EXPEDITION

SINCE the last issue of the JOURNAL more extensive reports than we have had heretofore have come in from Dr. Rudolph M. Anderson, the biologist of the Museum's expedition to the Arctic coast of North America east and west of the mouths of the Mackenzie River. For many months nothing was heard from him, but no news was considered to be good news, for bad news travels rapidly among the Eskimo, and no anxiety was felt regarding his welfare. Letters from both Mr. Stefánsson and Dr. Anderson were published in the April number of the JOURNAL, and we now have the privilege of publishing extracts from the narrative of the latter's experiences during the preceding months. He writes as follows:

HERSCHEL ISLAND, August 22, 1909.

* * * * Mr. Stefánsson and I left Flaxman Island October 20, 1908, going in opposite directions. I started east with one sled and eight dogs, four Eskimo, our employee Havinerk, his wife Mamayouk, their little girl, and an 18 year old boy named Kiòya. The latter had no place to stay for the winter and wished to accompany us as a "volunteer." He proved to be



134 MAP OF ARCTIC ALASKA, SHOWING REGION COVERED BY THE STEFÁNSSON-ANDERSON EXPEDITION

Richard Island is the large island just east of Mackenzie Bay. Toker Point is on the mainland east of Richard Island. The Eskimo Lakes parallel the coast line east of Toker Point. Baillie Island is southeast of Cape Bathurst. Cape Parry is the most easterly point shown on this map.

a good sheep hunter and a useful companion. We followed the coast line, in general, to the mouth of the Hula-hula River, about six miles west of Barter Island. Here we picked up a toboggan, very useful in the mountains, and fixed up our whaleboat cache. We took only three 50 lb. sacks of flour, two slabs of bacon, a few pounds of beans, and some tea and tobacco with us from Flaxman Island. We cached half a sack of flour here for our return trip, but it was eaten by wandering natives before we returned. There is plenty of driftwood along the coast for camping purposes, but inland, between the coast and the mountains, there is little to burn, only a few willow twigs and snags along the river bars. We found two families of natives living on the Hula-hula, and hunted with them during November, the entire party killing fifteen sheep (*Ovis dalli*). One mountain hunter, named Kunagnana, with his wife and three small children had been living on sheep for months. He had over thirty sheepskins on hand, besides having clad the whole family from head to foot in sheepskins. His shirt, coat, pants, stockings, boots, mittens, snow-shoe lacings, and even the little tent he lived in, were made entirely of mountain sheepskins.

Our flour and other "civilized rations," except tea and tobacco, were gone early in November, and for the next month we lived on mountain sheep "straight," with a few messes of ptarmigan thrown in. Willow ptarmigan were very common and rock ptarmigan rare in the creek valleys. On the north side of the mountains, it required very little effort to bag ten or fifteen ptarmigan in a couple of hours. Later in November, we joined forces with a party of five Eskimo whom we had met at Herschel Island the summer before — Auktelek and his wife Tulak, their grown son Akorak, and another young hunter named Pikalo, and the latter's father Kunasilek. Auktelek told me that several years before his brother Umegluk with two companions had crossed the "divide" from the head of the Hula-hula River and hunted on a river flowing south (I believe the middle or east branch of the Chandlar), a northern tributary of the Yukon, and had found plenty of tŭk-tū (caribou). There is an immense territory south of the Endicott Mountains and north of the Yukon which the white prospectors have not yet reached except in a few places. The Rampart House and Fort Yukon Indians do not range so far north except in summer, and the Eskimo seldom cross the mountains. To the knowledge of the natives, no white man had ever crossed the mountains in this region.

We decided to cross this mountainous divide. We hauled a load of meat and a little wood within a quarter mile of the summit and camped one night (December 3) above the willow line. We took the sleds over safely by putting ten dogs in harness, and with the help of six men boosting and pulling. Descending a rocky creek gorge, we reached large willows before night of

December 4. The second day devoted to hunting brought in one sheep out of a flock of eleven seen. The third day's travel brought us to green spruce trees. Ptarmigan were scarce, also hard to find as the river valley was wild. We were on pretty short rations before we struck the caribou herds in the high foothills on December 18. The snow was deep and soft on the south side of the divide, our sleds were soon stalled, and we were delayed for days cutting trees, hewing out boards and making toboggans. A trail had to be snow-shoed ahead, and travel was slow, all hands "slugging" in harness with the dogs. Two porcupine and a great gray owl proved welcome additions to our larder. Canada jays were observed a few miles north of the limit spruce trees, and ravens were often in sight. During the latter part of December we saw many caribou, at one time over a thousand within rifle range at one time,— a magnificent spectacle. We lived in tents until December 23, when we built a hut of poles covered with blocks of moss, living there until late in January, occasionally seeing caribou. They were continually moving eastward, and we were finally compelled to cross a low chain of hills to another large creek valley about twenty miles farther east. When we were down to our last day's food, we fortunately killed sixteen caribou, January 31, and one moose, February 4. This gave us meat enough to attempt the return journey. * * * * The return journey was easier than the descent, as the river was covered with ice. We often had difficulty in crossing places where the whole river half a mile wide was overflowed with several inches of water which perhaps had a very thin crust of ice over it — this at –50° Fahrenheit. Lowest temperature observed was –54° F. We recrossed the "divide" February 28 and reached Flaxman Island March 7, having been on a "straight meat" ration for four months,— two months without salt. All the party, however, were in fine health and condition.* * * * The usual procedure before moving camp is to pound up every bone and boil the fragments to extract the grease — as a result of which few bones are left on the mountains for future palæontologists to ponder over.

I made another trip to the Hula-hula River from Flaxman Island to bring out the balance of my skins and skulls, returning April 14, and met Mr. Stefánsson, whom I had not seen since October 20. After finishing the preparation of my specimens I started west from Flaxman Island, and sledded as far as Smith Bay. Here I found a note from Mr. Stefánsson who had preceded me, stating that advices had been received at Point Barrow to the effect that no whalers were coming into the Arctic Ocean this summer, and we were left to our own resources to get our belongings east.

We at once started hauling goods and supplies east from our cache at Smith Bay, and by strenuous effort with two sleds succeeded in getting five

sled loads of gear, and a thirty-three-and-one-half foot skin "umiak" within a few miles of the Colville delta before water overflowing the sea ice put an end to sled travel on June 14. Launched this boat on June 23 and have spent the time since then moving eastward, paddling, sailing or tracking. I have spent all available time in collecting, and have taken a fair series of eggs and nests, including whistling swan, black brant, black-billed and American golden plovers, turnstone sp., red-backed pectoral, Hutchins goose and semipalmated sandpipers, northern and red phalarope, snowflake, Lapland longspur, parasitic jaeger, red-throated loon, willow ptarmigan and others, all from the vicinity of Colville delta. * * * * Near Flaxman Island, we found several Herschel Island boats at the trading rendezvous to meet the Cape Smythe traders, and Ningakshuk, owner of a small sloop, kindly brought me, with several dogs and several hundred pounds of specimens, as far as Herschel Island. * * * *

CAMP NEAR TOKER POINT,
Arctic Coast, October 16, 1909.

* * * * Since my last letter, dated Herschel Island, we have progressed thus far eastward. My party sailed from Herschel Island at 3:30 A. M., August 25, with two whaleboats and one sloop — one boat belonging to us, the other to a young native named Pikalo, who, with his father, had agreed to come with our party and assist us, on consideration of being free to trap on his own account during the winter. The sloop belonged to Ningakshuk, who wished to go some distance eastward, as an independent venture. He aided us materially by carrying seven dogs and several hundred pounds of baggage through the Mackenzie delta.

We were often delayed by bad weather and head winds. It was necessary to stop for several days east of Shingle Point, as it is unsafe to cross the shoals on the western side of the delta, unless the wind is light and fairly S. W. Just east of Tent Island we were stopped again by head winds and foggy weather; then we cruised through a network of channels south of Langley Island, and after several days of tedious tacking and grounding, reached the mainland opposite the south end of Richard Island (Tūnūńŏk). At this point, our friend Ningakshuk decided that he dare not risk his sloop outside of the river, fearing heavy September gales in the shoal water outside.

We were consequently compelled to transfer our baggage from the sloop to the two whaleboats. This loaded them down heavily, without the seven people and eleven dogs which we were carrying. The channel east of Richard Island is very wide, but is shoal in many places, and a N. or N. E. wind raises a rough sea quickly. Entered the harbor at Kittigarynit September 26. Several Eskimo families were camped here, and were revelling

n abundance of fish, and "killalua" (white whale or beluga) meat and blubber. The natives are said to have killed about two hundred beluga near here during the summer, and every family has large caches of meat and plenty of oil — enough for the winter. * * * * This region has evidently supported a comparatively dense population in the past, as the beach is lined with old houses and every hill-top is strewn with graves.

On September 22, we reached a harbor in a little lagoon, known as Tūtōroktok, a few miles S. W. of Toker Point, just as a N. W. gale began to blow. The storm lasted three days, and on the morning of the 26th "young ice" had formed half way across the lagoon, while a heavy snow-fall had filled the sea with slush ice. With some difficulty, we moved the boats out to another and better harbor about half a mile away, and as there was no prospect of advancing farther by boat, we hauled the boats up on dry land for the winter.

As long as there was any open water, we caught fair hauls of fish in our nets every night, and after that have had fair success fishing through the ice. We have been getting our dogs into good condition for a long sled trip and have now all the frozen fish we can carry, as well as a cache of about 200 lbs. to leave here for the coming spring.

We are starting to-day with three sleds for the eastward to join Stefánsson, expecting to find him somewhere between Baillie Island and Cape Parry. Sled travel is not good even now. There has been no very cold weather, and the sea ice is not solid. The bays froze over earlier than usual at such temperatures, as the water was clogged by falling snow. Heavy snow-falls later prevented the ice from getting thick, and the salt ice is still wet and slushy under deep snow. Our intention is to follow the coast a little farther east than Warren Point, make a portage of "our sloop" across to the Eskimo Lakes, follow the lakes northeastward, then portage again, to strike the foot of Liverpool Bay, near Nicholson Island. From Nicholson Island we shall follow the east side of Liverpool Bay to Baillie Island. If Mr. Stefánsson is not at Baillie Island to make other arrangements, we shall proceed down the west coast of Franklin Bay around to Cape Parry and as much farther as circumstances will permit during the winter. * * * * The prospects are favorable for a successful season.

MUSEUM NEWS NOTES

EARLY in April, President Osborn returned from a journey in Arizona, Mexico and California partly in the interests of the Museum. Two of the great copper mines of Arizona and Mexico were visited, and with the aid of Dr. James Douglas, one of our Trustees, questions relating to the future exhibition of the geology and economics of copper were studied. In California, arrangements were made with the Mt. Wilson Observatory through Director George Ellery Hale to secure for the Museum copies of the most recent solar photographs. Dr. Hale has also consented to take the chairmanship of an appointive committee on astronomy. A visit to the palæontological collections of the University of California led to concluding important arrangements for future collecting on the Pacific coast with the cordially promised coöperation of Prof. J. C. Merriam of the University. An interesting trip was made to the famous bone beds of the Rancho La Brea.

THROUGH the generosity of Mr. Anson W. Hard, the Museum is fortunate in having secured an extensive series of old and valuable serapes and other blankets made by the Saltillo and other Indian tribes of Mexico and several of the tribes of our own Southwest.

SINCE our last issue the following persons have been elected to membership in the Museum: Sustaining Members, MESSRS. JOHN G. MILBURN and D. SCHNAKENBERG; Annual Members, MESSRS. PAUL B. HAVILAND, COLIN I. MACDONALD, WINTHROP PARKER and WARBURTON PIKE, DR. ALEXANDER LAMBERT, HON. FRANCIS M. SCOTT, MRS. J. B. DUER and MISS MABEL SATTERLEE.

MR. FRANK M. CHAPMAN writes that the party collecting material for the zonal group representing the fauna and flora of the eastern edge of the Mexican plateau is in good health and is rapidly attaining its objects. Mr. Chapman and Mr. Fuertes have made their studies from near Cordova to a point above timber line on Mount Orizaba, and the former's letter is, in part, as follows:

"Cordoba, 28 March, 1910.

"We got back from our mountain trip last night. The first two days on the mountain we had constant fog or rain, then it cleared and the weather was superb. We camped at 8,500, 9,500, 10,500 and 12,000 feet. At the highest camp the mercury fell to 12° F. The mountain has never been ascended from the side we were on and is said to be there unscalable. It looked so! I went only to timber line at 13,000 feet and then found permanent ice 100 feet higher. Here life ceased and further ascent would have served no purpose that I had in view, had it been possible.

"The temperate zone has been materially changed by man, and there is no first growth left, even in this unfrequented part of Mexico. The limit of human habitation is approximately marked by the limit of corn growing, or about 9,000 feet. Here we found magnificent forests of pine and spruce, with oaks six feet in diameter and over 100 feet high. Timber line is marked by the abrupt cessation of tree-growth, the last trees being 30 to 40 feet in height. We got an essentially complete list of Alpine birds and other data of value, including a large series of photographs."

Mr. Roy C. Andrews, of the Department of Mammalogy, is visiting the whaling stations of southern Japan, where the opportunities for the study of several species of cetaceans are particularly good.

Dr. Louis Livingston Seaman delivered a lecture at the Museum on Thursday evening, April 7, 1910, entitled "African Explorations and Adventures." Dr. Seaman has visited Africa on several occasions. His lecture was illustrated by stereopticon views of the territory of Uganda, the shores of Albert Nyanza and other regions, and he dealt particularly with his studies upon the tsetse-fly and sleeping sickness and incidentally with the ethnological and geographical features of his expeditions.

On Friday, April 15, from four till six and from eight till ten o'clock, there was held a private exhibition of the collection of African game made in 1909 by Messrs. E. Hubert Litchfield, Bayard Dominick, Jr., and Henry Sampson, Jr. The collection includes more than three hundred heads and illustrates admirably the range of variation in size and color of the animals that have made East Africa famous. During the afternoon and evening a large series of photographs illustrating the capture

of the animals, the physical aspect of the country through which the expedition passed and the primitive inhabitants, was thrown upon the stereopticon screen. The newly arranged African Hall is now open to the public.

THE collection of meteorites in the Foyer has been enriched by the recently acquired siderite or iron meteorite to be known as Knowles, the name of the post office in Oklahoma nearest to where it was found. The find has not yet been described, but a full account with illustrations will soon be published. The mass weighs about 355 pounds. There has also been placed on exhibition here the second largest known mass of the siderolite form of the Brenham (Kansas) meteorite. This weighs 218 pounds and replaces the two smaller masses of the same fall that have heretofore been on exhibition.

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On Tuesday evenings, as announced:

The Linnæan Society of New York;
The New York Entomological Society;
The Torrey Botanical Club.

On Wednesdays, as announced:

The Horticultural Society of New York;
The New York Mineralogical Club.

On Friday evenings, as announced:

The New York Microscopical Society.

The programmes of the meetings of the respective organizations are published in the weekly *Bulletin* of the New York Academy of Sciences and sent to the members of the several societies. Members of the Museum on making request of the Director will be provided with the *Bulletin* as issued.

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PORTION OF MODEL IN THE FORESTRY HALL

NO. 32 OF THE GUIDE LEAFLET SERIES—SEPTEMBER, 1910

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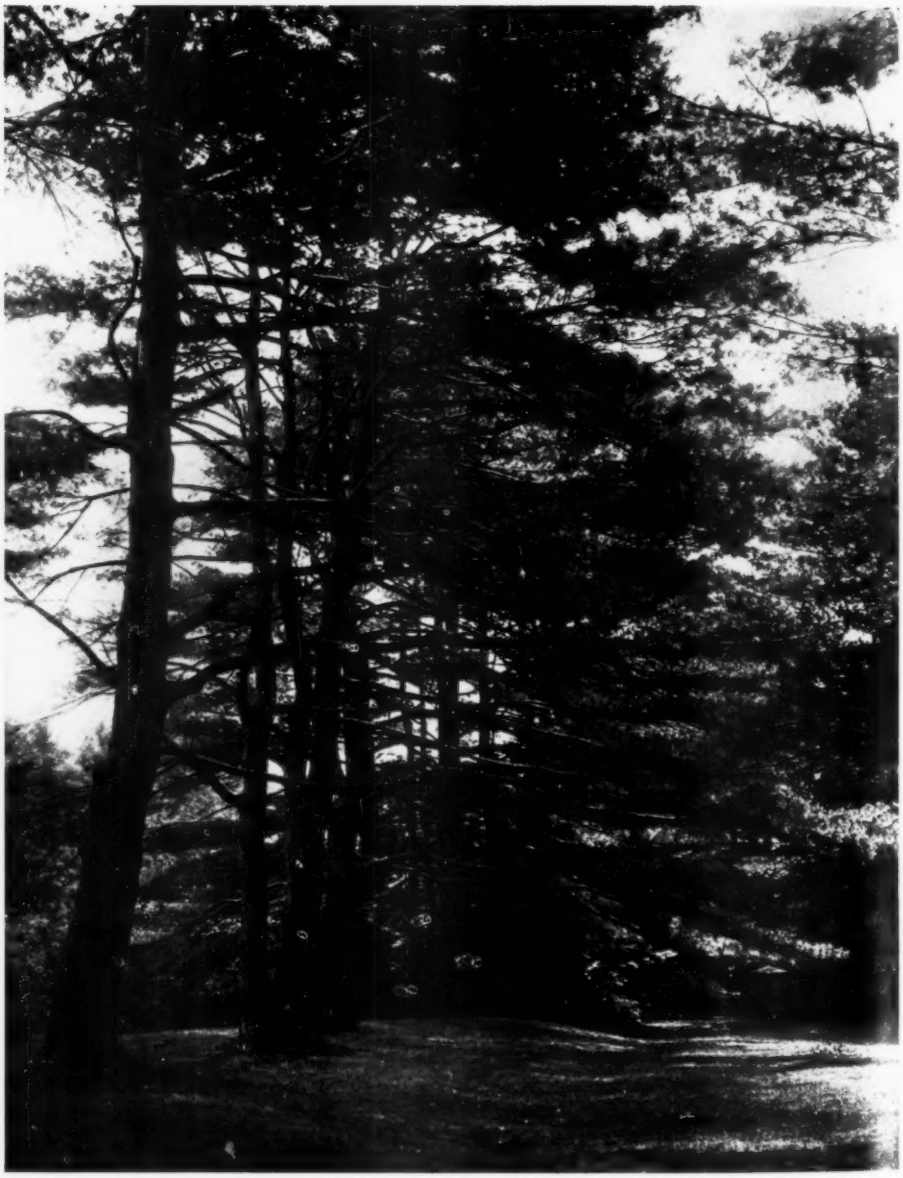

WHITE PINES

On the estate of the late Morris K. Jesup, Lenox, Massachusetts

TREES AND FORESTRY

AN ELEMENTARY TREATMENT OF THE SUBJECT BASED ON THE

Jesup Collection of North American Woods

IN THE

AMERICAN MUSEUM OF NATURAL HISTORY

By MARY CYNTHIA DICKERSON, B. S.
Curator of Woods and Forestry

NEW YORK
Published by the Museum
September, 1910

NO. 32

OF THE

GUIDE LEAFLET SERIES

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

MARY CYNTHIA DICKERSON, Editor

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PREFATORY NOTE

The author expresses gratitude to all those who have extended courtesies during the preparation of this *Leaflet*. Especially are thanks due to the Honorable Gifford Pinchot, President of the National Conservation Association and to Professor J. H. Toumey, Director of the Yale Forest School, who as members of the Appointive Committee on Woods and Forestry of the American Museum read the *Leaflet* in proof and gave valuable suggestions; also to the United States Forest Service and Doubleday, Page and Company, who allowed the use of photographs for many of the half-tones. Primarily, of course, indebtedness is due to the Forest Service, since much of the subject matter concerning practical points has been compiled from its work.

The pamphlet has been made to cover a wide field in order not to lack in suggestiveness along the various lines of interest of the Museum's visitors; thus of necessity it touches many matters briefly. Again forestry is so rapid-growing a subject to-day that even a few months are likely to put out of date these briefly stated facts along certain practical lines. The latest information of markets and methods as well as of legislation on conservation at home and trade relations with foreign countries must always be sought in later publications, such as Government bulletins and the monthly periodical of the American Forestry Association.

The chapter intended to help in the identification of trees in their winter condition, although covering trees represented by an armful of twigs which one might gather in the Eastern United States, is so incomplete that it has been given a subordinate place as an appendix. The line cuts for this chapter were made from freshly gathered material, under the supervision of the author, by Miss Alma Field of the Rhode Island School of Design, Providence.

AMERICAN MUSEUM OF NATURAL HISTORY, *September, 1910.*

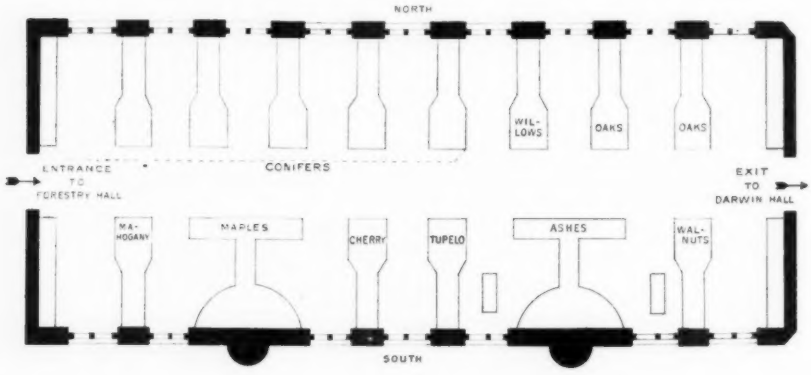


DIAGRAM OF THE FORESTRY HALL, FIRST FLOOR, EAST FROM THE MAIN FOYER
AMERICAN MUSEUM OF NATURAL HISTORY

The Forestry Hall contains the Jesup Collection of Woods representative of the five hundred species of North American trees. These woods are arranged in related groups or families, the specimens of large market value holding prominent place in each group

SOME BOOKS ON TREES AND FORESTRY

Boulger, Geo. S. Wood. London: Longmans, 1902. $3.00

Dame, L. L. and Brooks, H. Trees of New England. Boston: Ginn, 1902. $1.50

Fernow, B. E. The Care of Shade Trees. New York: Holt, 1910. $2.00

Economics of Forestry. New York: Crowell, 1902. $1.50

Forest Service, U. S. Department of Agriculture, Washington.

Fox, W. F. and Hubbard, W. F. The Maple Sugar Industry. Bulletin No. 59. 1905. Free

Graves, H. S. Practical Forestry in the Adirondacks. Bulletin No. 26. 1899. Free

The Woodman's Handbook. Bulletin No. 36. 1903. Free

Graves, H. S. and Fisher, R. T. The Woodlot. Bulletin No. 42. 1903. Free

Herty, Charles F. A New Method of Turpentine Orcharding. Bulletin No. 40. 1904. Free

Hubbard, Wm. F. The Basket Willow. Bulletin No. 46. 1904. Free

McClatchie, A. J. Eucalypts Cultivated in the United States. Bulletin No. 35. 1902. $1.00

Pinchot, Gifford. A Primer of Forestry. Part I — The Forest. 35 cents; Part II — Practical Forestry. 30 cents

Roth, F. Timber: an Elementary Treatise on the Characteristics and Properties of Wood. Bulletin No. 10. 1895. Free

Sherfesee, W. F. Wood preservation in the United States. Bulletin No. 78. 1909

Sudworth, Geo. B. Check List of Forest Trees of the United States. Bulletin No. 17. 1898. 15 cents

Forest Influences. Bulletin No. 7. 1892. Reprinted, 1902. 15 cents

A Short Account of the Big Trees of California. Bulletin No. 28. 1900. 10 cents

Fürst, H. The Protection of Woodlands (John Nisbet *trans.*) New York: Jenkins, 1893. $3.50

Graves, H. S. Forest Mensuration. New York: Wiley, 1906. $4.00

Green, S. B. Principles of American Forestry. New York: Wiley, 1903. $1.50

Hough, R. B. Handbook of Trees of the Northern States and Canada. New York: Hough, 1907. $6.00

Marsh, G. P. The Earth as Modified by Human Action. New York: Scribners, 1898. $3 50

Parkhurst, H. E. Trees, Shrubs and Vines of the Northeastern United States. New York: Scribners, 1903. $1.50. (Gives the trees of Central Park, New York)

Roth, F. A First Book of Forestry. Boston: Ginn, 1902. 75 cents

Sargent, C. S. Manual of the Trees of North America. Cambridge: Riverside Press, 1905. $6.00

The Silva of North America. Cambridge: Riverside Press, 1891–1902. 14 vols. $350

Schlich, Wm. Manual of Forestry. London: Bradbury, Agnew. 1894–1902. 5 vols. $17.20

Schwappach, A. Forestry. New York: Macmillan, 1905. 50 cents

Snow, C. H. Principal Species of Wood. New York: Wiley, 1903. $3.50

Stone, Herbert. The Timbers of Commerce. London: Rider, 1904. $3.00

Van Hise, C. R. Conservation of Natural Resources in the United States. New York: Macmillan, 1910. $2.00

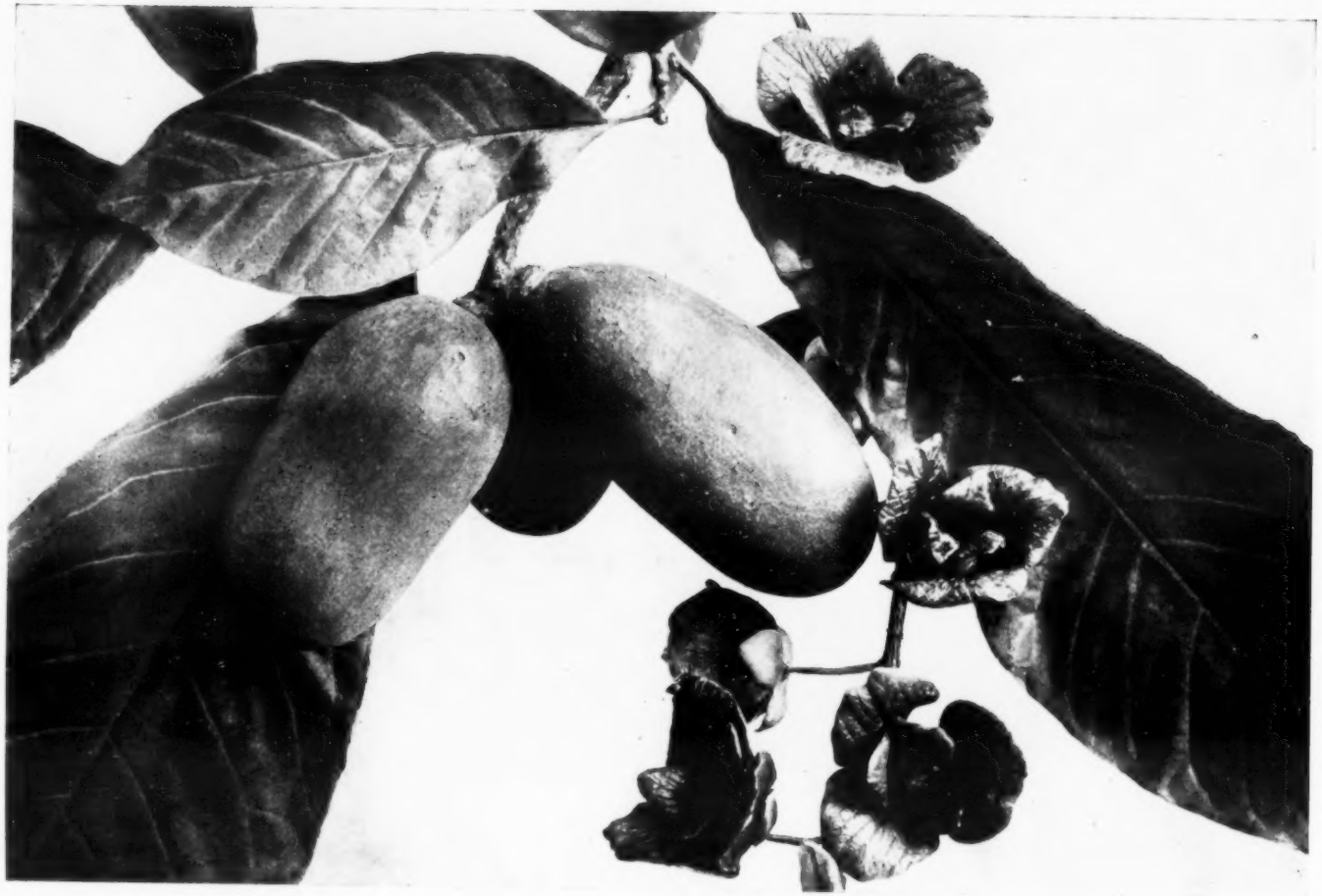


FIG. 1. FLOWERS AND FRUITS OF THE PAPAW (*Asimina triloba*)

Portions of the models in Forestry Hall, Case E, 3. The wine-colored flowers bloom in April; the fruit is ripe in September and October. Wood inferior. Tree planted for ornament

TREES AND FORESTRY

PREPARED FOR USE WITH THE JESUP COLLECTION OF NORTH AMERICAN WOODS

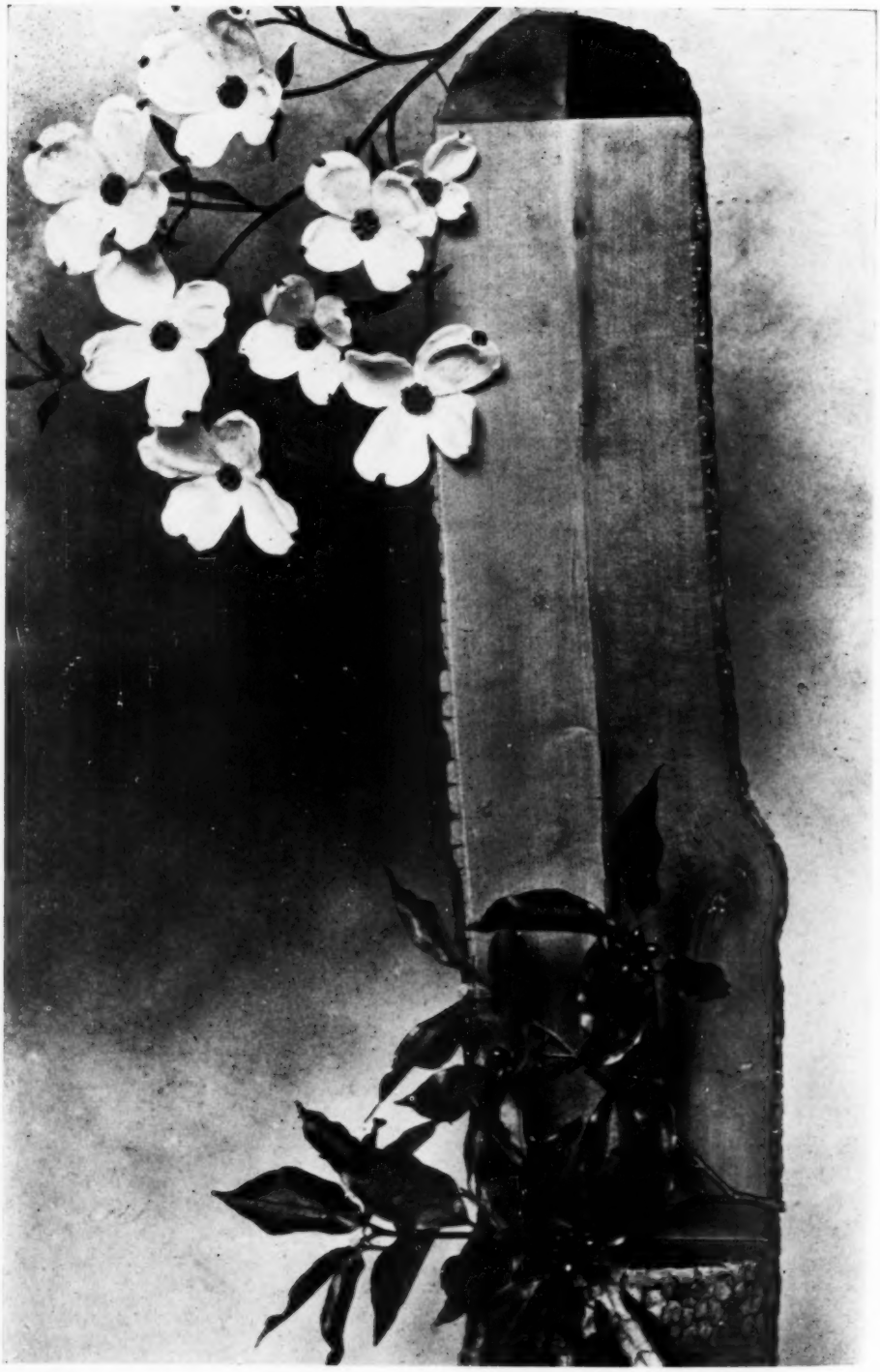
INTRODUCTION

THE Morris K. Jesup Collection of North American Trees, in the Forestry Hall of the American Museum of Natural History, is designed for the student, artisan and forester, and for the man commercially interested in woods, as well as for those who enjoy familiarity with the woodland and wish to increase their enjoyment by extending their familiarity.

The collection was begun by Mr. Jesup in 1880, and throughout his presidency of twenty-seven years, it received his constant attention. Indeed, in its completeness and attractiveness, its scientific correctness and educational value, it is a splendid example of what he desired an exhibition in a scientific and educational institution to be. In its now practically perfected condition, it displays in related groups or families more than five hundred species of the trees of North America. Each tree is represented by a section of trunk 5 feet high, cut lengthwise radially 2¼ feet, the cut surface showing the color and graining of the quartered lumber in its natural and polished state (see Figs. 2, 5, 6 and 42). Also for the more common trees, there is a separate piece of the wood which may be handled and tested for lightness, softness, resonance, odor and other qualities.

One of the most remarkable features of the collection lies in its accompanying models of tree leaves, flowers and fruits (see Cover and Figs. 1, 2, 5, 6 and 42). So perfectly are the representations executed that it is often impossible to discover even by careful scrutiny how much may be original and how much reproduced. There are flowers of the decorative magnolias, of basswood interesting to bee keepers, curious fruits of sassafras, persimmon, and Osage orange, autumn foliage of oak, sweet gum and sumach.

This leaflet is designed to accompany the Jesup Collection of Woods, emphasizing its great commercial value by adding practical suggestions for the growth of trees. It presents the status of the forest conservation question in the year 1910.



10 FIG. 2. FLOWERING DOGWOOD (*Cornus florida* LINN.)

New England to Florida, westward to Minnesota and Texas. Wood, often called boxwood, unusually heavy, tough, strong and hard, receiving high polish, suitable for use in carving, engraving, turnery and for bearings of machinery; used largely for shuttles in the textile industry. Forestry Hall, Case E, 7

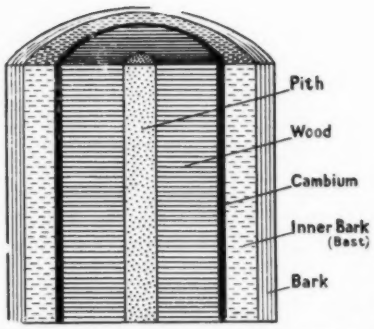


FIG. 3. STRUCTURE OF A TREE TRUNK ONE YEAR OLD

It is a series of cylinders one within another. The cambium is the living part

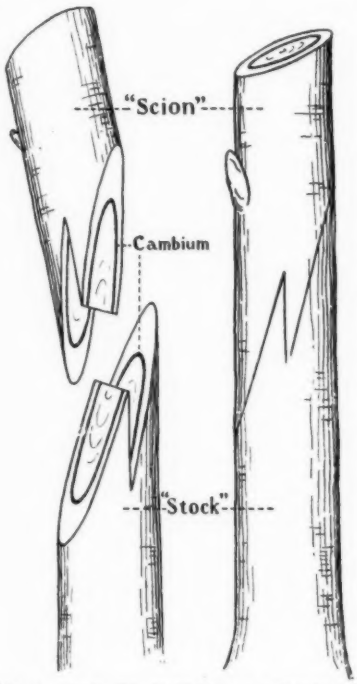


FIG. 4. KEY TO SUCCESS IN GRAFTING

The living cambium of the "scion" must join exactly and become continuous with the living cambium of the "stock," or the process will not be successful

STRUCTURE AND LIFE OF A TREE

A TREE is an individual and as such it is alive, with parts dividing the labor pertaining to life and coöperating for the good of the whole; but, on the other hand, a tree has only a small fraction of its great mass made up of living substance. When very young, it consists entirely of living substance; but long before one year has passed it contains a large accumulation of dead material the great bulk of which is "wood," filling up and making strong the trunk, branches and roots.

The one-year old trunk, examined from the central axis to the outside, has a definite structure as follows: (1) a rod of *pith*, (2) a cylinder of *wood* embracing the pith, (3) a cylinder of *inner bark* (*bast*), thinner-walled than the wood cylinder and embracing it, and outside of these, (4) an enfolding cylinder of *bark* (Fig. 3). All send off parts to right and left into the leaves and, after the first year, into the branches. The living part, called the *cambium*, a living cylinder of scarcely appreciable thickness, lies between the wood and the inner bark. It is easy to understand why, in grafting, the living layer of the branch to be attached must be made to join exactly and become continuous with the living layer of the branch which is to receive it, or the grafting will not be successful (Fig. 4).

Each year this living cylinder of

FIG. 5. WILD PLUM (*Prunus americana* MARSH)

New York to Texas and Colorado. Good stock on which less hardy varieties are grafted. Wood heavy, hard, strong and close-grained. Forestry Hall, Case D, 10

FIG. 6. OSAGE ORANGE, ILLUSTRATING "HEARTWOOD" AND "SAPWOOD" 13

The formation of the heartwood follows very rapidly on the growth of sapwood so that the latter is only a narrow layer of lighter wood next the bark. The cambium and inner bark are too narrow to be defined in the photograph. Forestry Hall, Case F, 20 (*Toxylon pomiferum* Raf.)

cambium produces new wood everywhere on its inner surface (living material while forming, non-living when formed), a cylinder of new wood enfolding immediately the wood of the year before (Fig. 7). Wood never lengthens after once formed, so a trunk grows in height only by additions from living buds at the top (Fig. 8), but a tree grows in diameter annually by just the thickness of the new cylinder of wood (a ring of wood when seen at the end). The thickness of the annual layer in any species depends on the length of the growing season in the given region and on the age of the tree, those wood cylinders formed in early life being relatively thick-walled and later ones successively more and more thin-walled. A further fact is true, however, and to be remembered in economic tree planting, that the diameter increase of any tree is always immediately dependent on its growing space, on soil, light and other conditions of the surroundings, factors which to a large extent we can control.

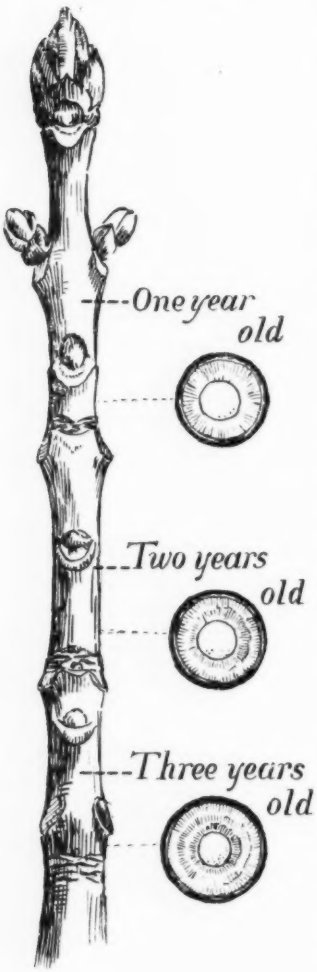


FIG. 7. WHITE ASH TWIG

Cross section to show rings of wood, corresponding to the cylinders of wood in the twig. Compare with Fig. 8

This method of growth places the older wood as "heartwood" in the center of the trunk, while the younger wood, called "sapwood," is outside of this. Heartwood and sapwood may differ in weight and in color, since the heartwood is likely to be a storehouse for coloring matter, or gummy, resinous or mineral substances which have come into the tree from the soil or are the waste from vital processes. Heartwood is more durable than sapwood because it does not often contain starch or other organic matter, and therefore is less liable to the attacks of insects and to the growth of the organisms that cause decay, also on its change from sapwood depositions of material more or less antiseptic take place. Trees in which the formation of heartwood does not follow rapidly on the growth of sapwood are the oaks, elms, walnuts and pines. Some trees

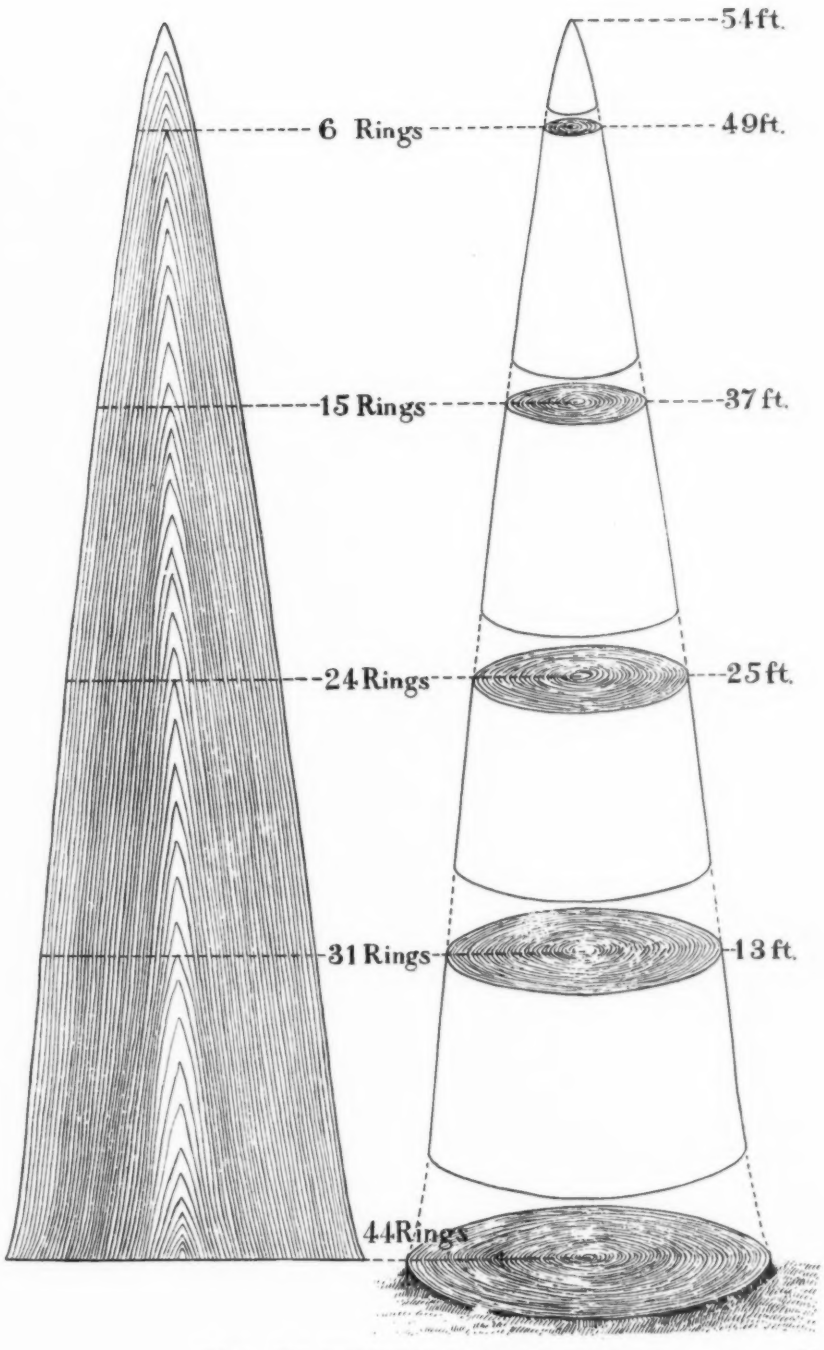


FIG. 8. THE PROGRESSIVE GROWTH OF A TREE 15

A tree grows in diameter each year by the addition of a cone of wood which never increases in height after being formed. Compare with Fig. 7. The age of the trunk is shown at various heights (44 years at the ground, 6 years near the top, corresponding to the number of rings in cross section)

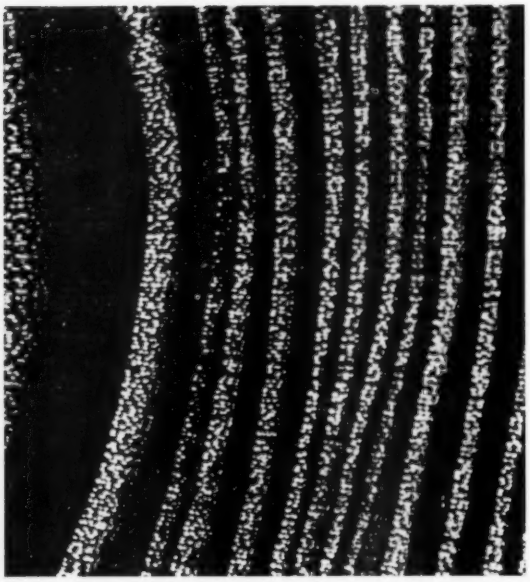


FIG. 9. CROSS SECTION OF CHESTNUT
Showing the porous "spring wood" and more compact "summer wood"

noted for their narrow sapwood are locust, mulberry, Osage orange (Fig. 6), chestnut and larch.

Also in the wood of each cylinder or ring, there may be a differentiation in color and often in structure, that part of the cylinder which grows rapidly in the spring proving light in color and perhaps porous (spring wood) (Figs. 9 and 10). In fact, it is difficult to count the annual rings in birches, hornbeams, maples, poplars and willows, trees in which so little summer wood is made, that the spring wood of one year appears to adjoin the similar spring wood of the next year.

We speak of the beginnings and additions of wood as cylinders, but, in truth, they are cones, as a consideration of Figs. 7 and 8 will prove. A cut through the central part of a log so that the saw practically cuts through a radius of each cone will produce a board with its surface showing wood bands or lines relatively parallel (Figs. 11 and 13; radial or quartered cut of

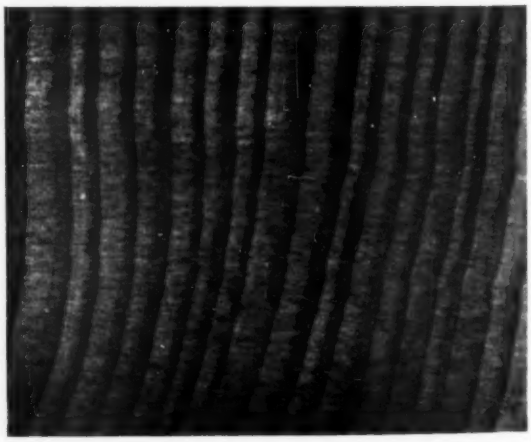


FIG. 10. CROSS SECTION OF DOUGLAS SPRUCE
Indicating variation of spring and summer wood

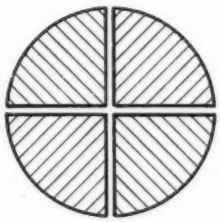


FIG. 11. ONE METHOD OF QUARTER-SAWING

Quartered boards warp and split less than tangential cuts of lumber because cut in the direction of the pith rays. Compare with Figs. 13, 18 and 20

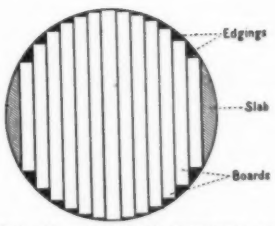


FIG. 12. COMMON METHOD OF SAWING TIMBER

No quartered lumber results, with the exception of a few boards in the middle. There is waste in any method of sawing but charcoal blast furnaces and chemical plants may convert bark, limbs, edgings and even sawdust into some valuable product

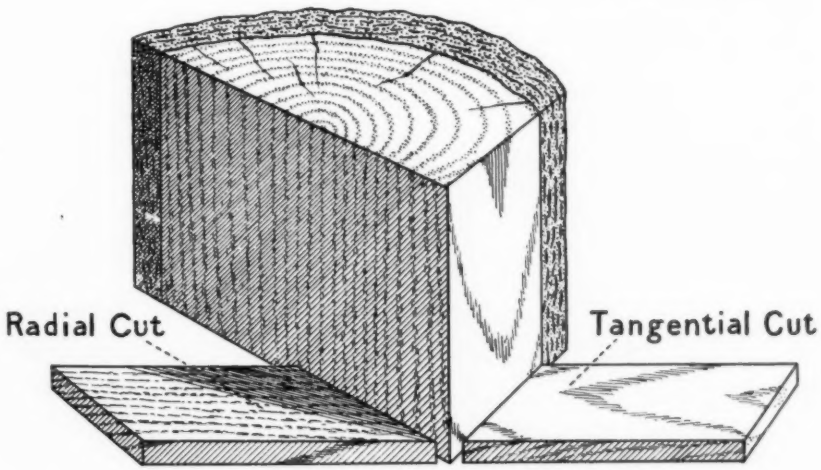


FIG. 13. RADIAL AND TANGENTIAL CUTS OF LUMBER

Boards cut from the central part of a log (and so at right angles to the wood rings and in the direction of the pith rays) produce radial, rift, or quartered lumber; other boards (tangent and oblique to the wood rings and more or less at right angles to the pith rays) give tangential, common, or bastard cuts of lumber. Compare with Figs. 11 and 20

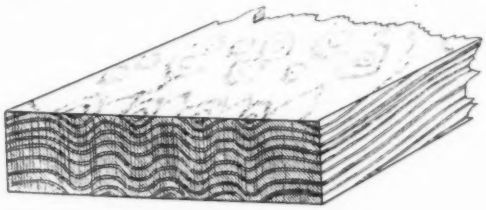


FIG. 14. BIRD'S EYE MAPLE

Occasionally there is a tree in which the wood cylinders have fluted walls. Cutting through these fluted walls produces the "bird's eye" marks on the boards

lumber). In a cut downward through a log some distance out from the center, the saw continually strikes and cuts through the sloping walls of wood cones and the resulting board shows in its midline wood bands appearing as concentric angles or U-shaped figures (Figs. 12 and 13, tangential or bastard cut of lumber). The U-shaped marks may be the result also of irregularity in the growth of the tree due to the effects of sun, prevailing wind or other external agency. Occasionally the wood cylinders for some unknown reason have fluted walls, in which case it is easy to see how a board gains the appearance called "bird's eye," illustrated in hard maple (Fig. 14).

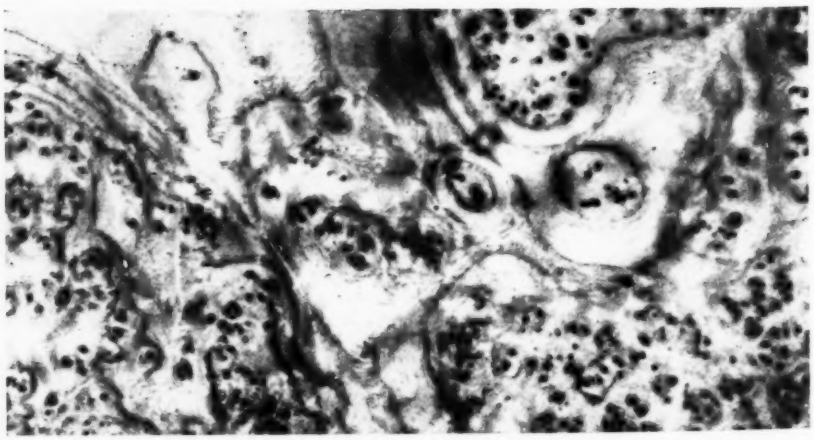


FIG. 15. BLACK ASH BURL

Irregularity of the wood cylinders in burls or knots causes the unusual and often very beautiful effects seen in burl veneers

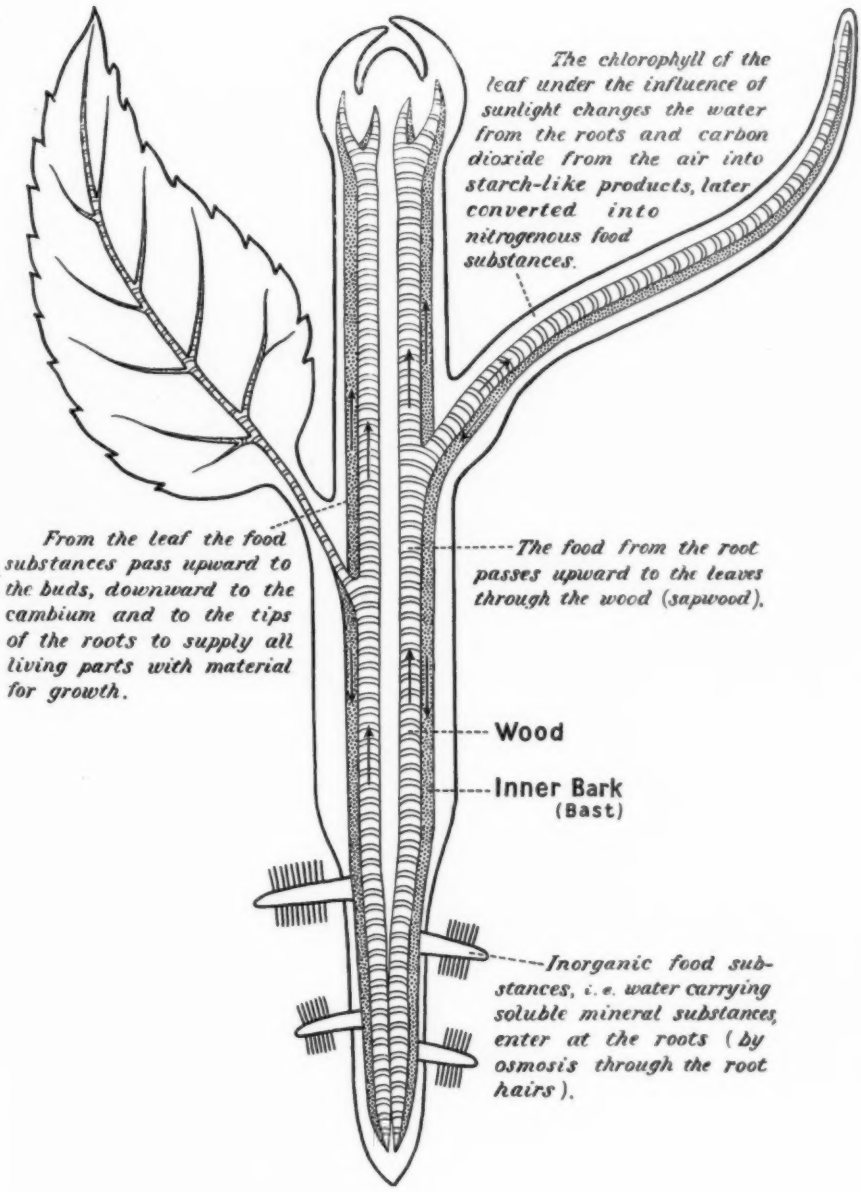

The chlorophyll of the leaf under the influence of sunlight changes the water from the roots and carbon dioxide from the air into starch-like products, later converted into nitrogenous food substances.
From the leaf the food substances pass upward to the buds, downward to the cambium and to the tips of the roots to supply all living parts with material for growth.
The food from the root passes upward to the leaves through the wood (sapwood).
Wood
Inner Bark
(Bast)
Inorganic food substances, i.e. water carrying soluble mineral substances, enter at the roots (by osmosis through the root hairs).

FIG. 16. DIAGRAM SHOWING COURSE OF THE SAP

It passes from the roots through the wood to the leaves, and after its chemical change there, through the inner bark (bast) to all growing parts

Irregularity of the wood cylinders in "burls," overgrown knots and excrescences occasionally found on various trees, causes the unusual and often very beautiful effects seen in burl veneers (Fig. 15).

It is the work of these various tissues in coöperation for the tree's maintenance as an individual that is of most interest. Water containing lime, potash and other minerals in solution, is taken up from the soil through the roots. This food cannot be used directly for growth by the tree any more than it could be by man. It is sent upward through the sapwood to the leaves of the tree. A tree may be girdled, that is, cut to the cambium, and also may be hollow through the whole extent of its heartwood, yet it will live for some time if there is continuous sapwood

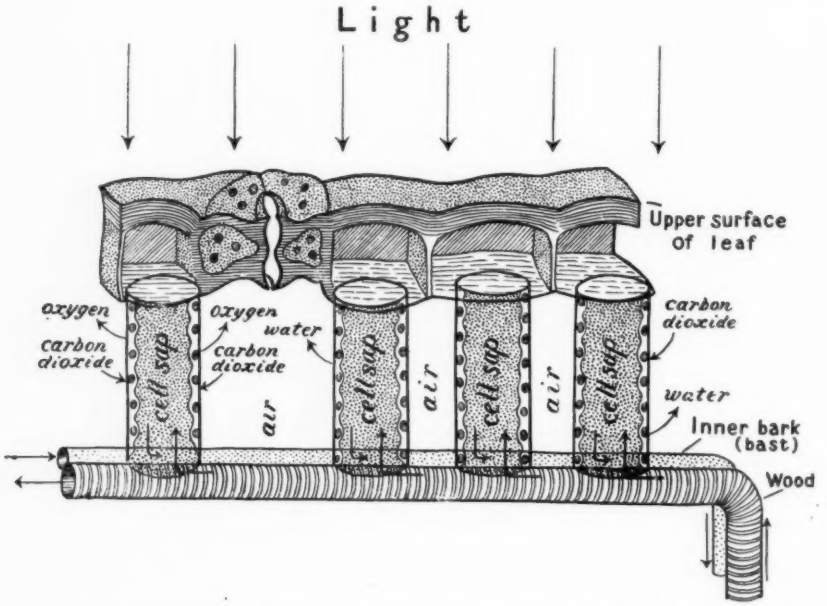


FIG. 17. ACTIVITIES GOING ON IN THE "CELLS" AND AIR SPACES OF A LEAF

(1). Under the sun's heat, water is continually evaporating from the leaf. A tree must lift several thousands of lbs. of water to the leaves to get 1 lb. of mineral matter in solution in the sap. The greater part of this water is evaporated from the leaves. A birch tree gives off 700–1000 lbs. of water daily; a single oak sends off into the air 130 tons of water annually

(2). Carbon dioxide is absorbed continually in daylight by the leaf to make possible the starch-forming process, while free oxygen is at the same time given off as a waste product from this same process. This absorption of carbon dioxide and outpouring of oxygen makes one explanation of the fact that park and street trees increase the healthfulness of a city

from root to leaves. The living green substance (chlorophyll) of the leaves under the influence of sunlight breaks apart the hydrogen and oxygen, elements in this water gained from the roots, and at the same time separates the carbon and oxygen, elements in carbon dioxide gained from the air, and recombines the three, hydrogen, oxygen and carbon, to make various starch-like products. This chemical work of green plants, defying man's efforts to imitate, creates food for animal life on the globe and is, in fact, the only source of that food. Later, the starch is changed to complex substances, largely because of the addition of nitrogen, and passes through the inner bark (bast) of the trunk, upward to give food to the growing buds, downward to supply the living cambium throughout its length with material for a new wood layer, and to give nourishment to the living tips of the roots (Fig. 16).

These plant activities, mechanical and chemical, are not fully understood. Osmosis or the passage of liquids through an organic membrane explains the entrance of water carrying soluble substances into the roots; and since in osmosis the movement is more rapid in the direction of the stronger solution, which in this case is within the roots, the continual passage of water into the roots must create considerable pressure upward. This root pressure accounts in some degree for the rise of water in the trunk. Root pressure in birch trees will lift water in the tree trunk to a height of 84.7 feet. A second force acting to carry the current upward through the sapwood is probably capillarity (the force which causes rise of a liquid through any porous substance). A third force is the strong attraction naturally existing between particles of wood and particles of water. A fourth is certainly the continual and often rapid evaporation of water from the tree's enormous leaf surface which lies spread out under the heat of the sun (Fig. 17).

Other structures of the trunk, complicating an understanding of the appearance of lumber, are short, thin plates made of a substance like the pith, arranged radially and vertically through the wood but irregularly with reference to one another (Fig. 18). These plates, called pith rays, show as radial lines in a cross-section of a log (see upper section, Figs. 19 and 20). They produce what is known as the silver grain of lumber, inconspicuous short lines on the surface of tangential boards because the plates are cut through their length and thickness, but often conspicuous in quartered lumber where, cut through length and width, the plates are sometimes exposed for two or more inches on the board's surface (see lower section, Figs. 19 and 20). The pith rays in different species of trees differ to such an extent that, like the variations of spring and summer wood, they serve to identify different kinds of wood. In oaks the rays are long and

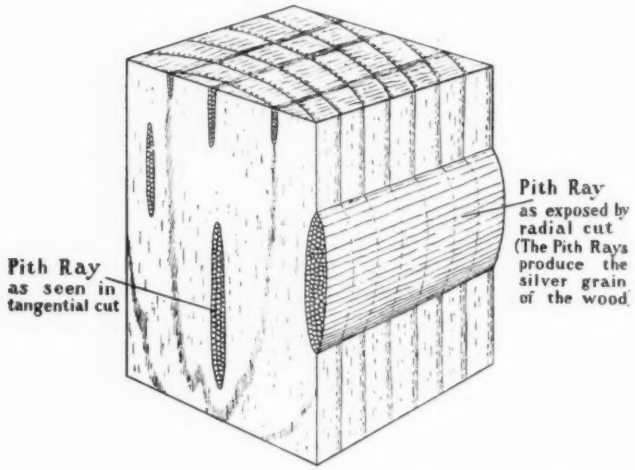


FIG. 18. RELATIVE POSITION OF PITH RAYS AND WOOD RINGS

In a radial cut, the pith rays may show as broad bands (silver grain); in a tangential cut, they appear only as short lines. Compare with Figs. 19 and 20

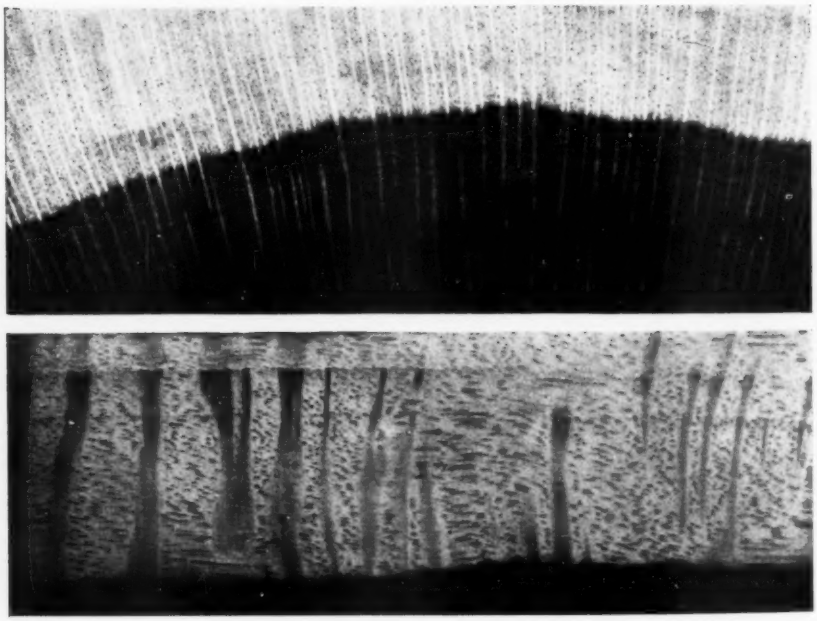


FIG. 19. OAK WOOD SHOWING PITH RAYS

Narrow radiating lines in cross section, broad silvery bands in the quartered wood. Compare with Figs. 18 and 20

FIG. 20. STUDY OF OAK WOOD

h rays of a log seen in cross and radial cuts and at the line of meeting of the two surfaces

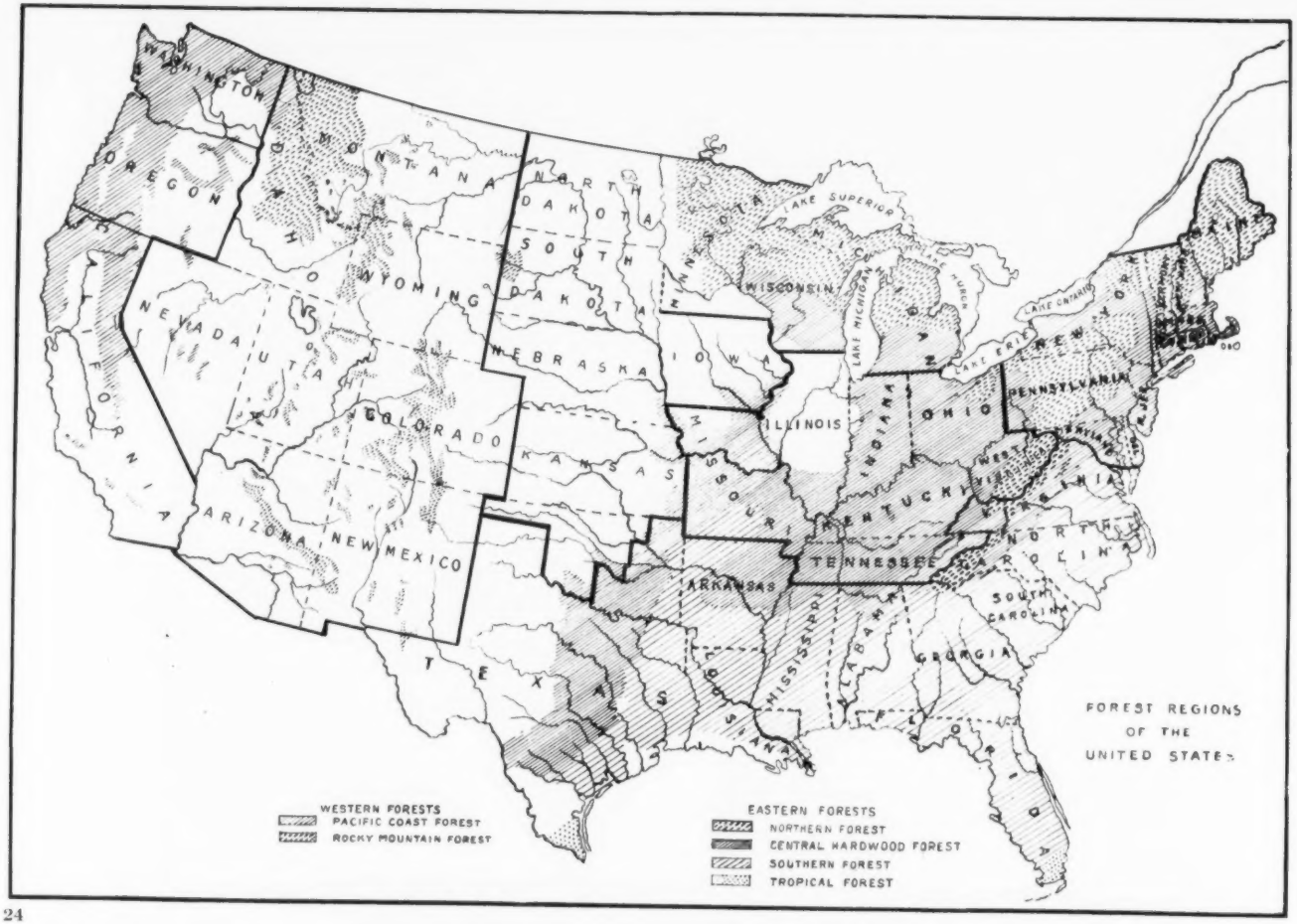


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Fig. 21. *Northern Forest* — Spruce, second-growth white pine, hemlock and hardwoods. *Hardwood Forest* — southern portion, hardwoods; northern, cedar, tamarack, hemlock and white pine. *Southern Forest* — Lowest lands, cypress and hardwoods; next [illegible] southern pine; plateaus and lower mountain regions, pure hardwood; highest ridges, spruce, white pine and hemlock. *Rocky Mountain Forest* — Western yellow and lodgepole pines. *Pacific Forest* — Douglas fir, western hemlock, sugar and western yellow pines, redwood, cedar

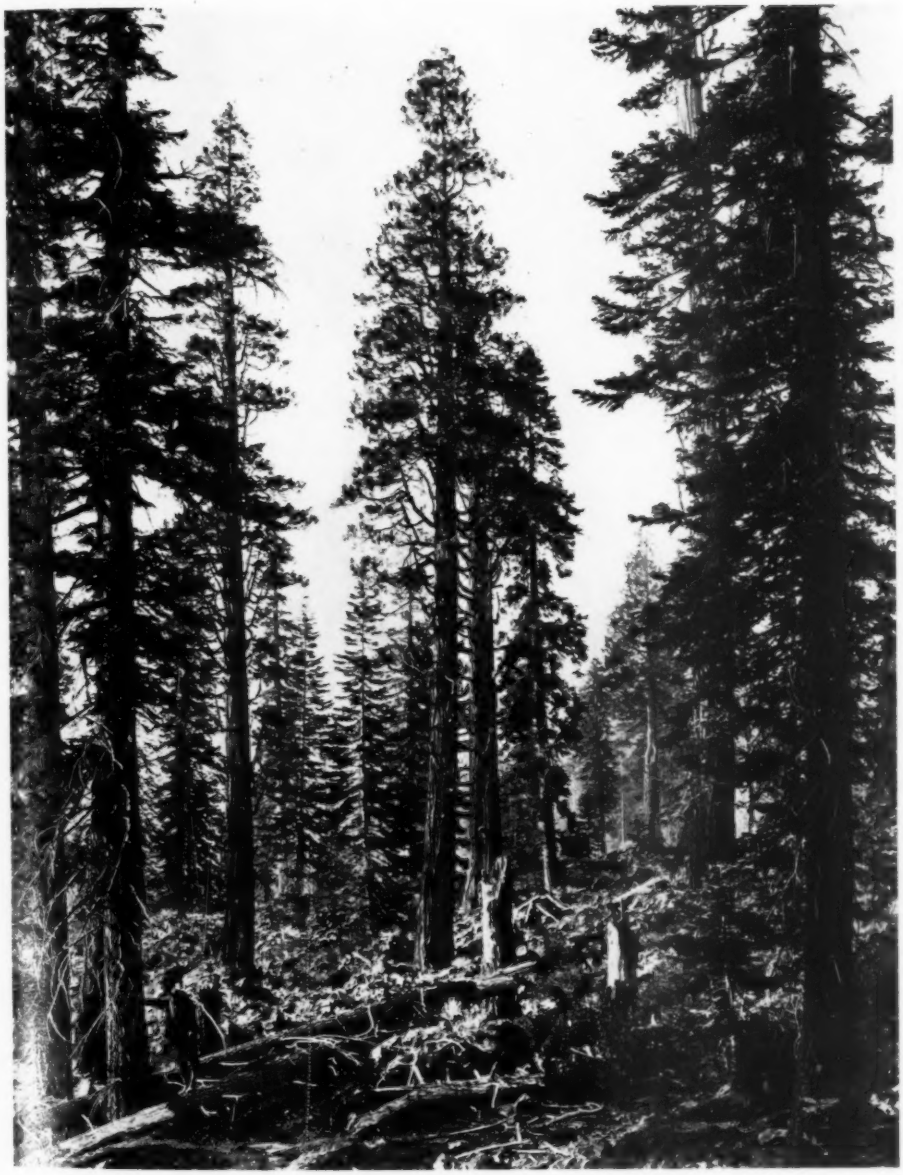

FIG. 22. IN THE PACIFIC FOREST

Virgin growth of Incense Cedar and Red Fir, Siskiyou County, California. (Incense Cedars in the centre, Red Firs at right and left). See colored transparency, Forestry Hall

broad; in maple, elm and ash they are moderately broad; in willow, they can be discovered only by means of a magnifying glass.

The presence of the pith rays proves descent from more primitive trees of much less strength of trunk, their bulk being made up of pith as are the stalks of corn of to-day. Pith rays are lines of weakness in the trunk; especially are they such in the lumber. Boards cut with the pith rays (radial or quartered) are, of course, less liable to warp and split than are those cut across them (tangential).

FORESTS, THE WEALTH AND THE NECESSITY OF THE NATION

ORIGINALLY the people of America possessed great forest wealth which they did not realize exhaustible, wholly ignorant of the country's growth in population and industries. To-day a timber famine is in sight, and there is still far too little realization that this forest wealth is exhaustible; we are destroying annually three and a half times as much wood as new growth adds. Unless all forests from this time on are managed according to some system which will no longer exhaust, but instead, will reconstruct, it is thought that twenty years will see the end of the timber supply in the United States. The original forests covered 850,000,000 acres; at present 550,000,000 acres[1] are forest lands but in large part the trees represented in these forests have only a fraction of the commercial value of those of the primeval forest. (See Figs. 21 and 22.)

An even more impressive view of the situation is given by the following figures, which are averages calculated for the five years previous to 1908, showing the ten countries that lead in the net wood exports and net wood imports respectively:

Countries Selling Wood	Tons	Countries Buying Wood	Tons
Russia with Finland	5,900,000	Great Britain and Ireland	9,290,000
Sweden	4,460,000	Germany	4,600,000
Austria-Hungary	3,670,000	France	1,230,000
Canada and Newfoundland	2,144,000	Belgium	1,020,000
Norway	1,040,000	Denmark	470,000
United States	1,020,000	Italy	420,000
Roumania	60,000	South America	330,000
India	55,000	Spain	210,000
West Coast of Africa	28,000	Egypt	200,000
West India, Mexico, Honduras, etc.	13,000	Holland	180,000

[1] The report of the State Commissioner for January 1, 1910, gives to New York State a holding of 1,841,523 acres of forested land, including 1,530,559 acres in the Adirondacks and 110,984 in the Catskills.

FIG. 23. A SILT BAR ON THE MISSISSIPPI RIVER

A deposit of the fertile constituents of surrounding land. This not only represents the barrenness of the land from which it came, but forms an obstruction to navigation, which must be removed by dredging

Thus it is seen that a large part of the world is getting its wood from Russia, Sweden, Austria-Hungary and Canada. The situation cannot endure, however, for these countries are destroying more forest than they are reproducing. What is in view therefore, is a world-wide wood famine.

Disastrous as a wood famine might prove to the industries of the country, it is not the only result attendant on the destruction of forests. The country faces problems of flood, drought and drying winds, of soils washed of their fertility, streams and harbors unnavigable because of irregular water-flow and because filled with tons of silt from soil erosion (Fig. 23), and all of these problems as well as questions of irrigation depend largely for their satisfactory solution on attention to the country's forests.

That they do thus depend lies in the fact that forests convert the region they occupy into a vast "sponge" for absorbing and holding water. It is said that the Croton Watershed controlling New York City's water supply needs at least 1,000,000 trees planted to husband the rainfall.[1] The

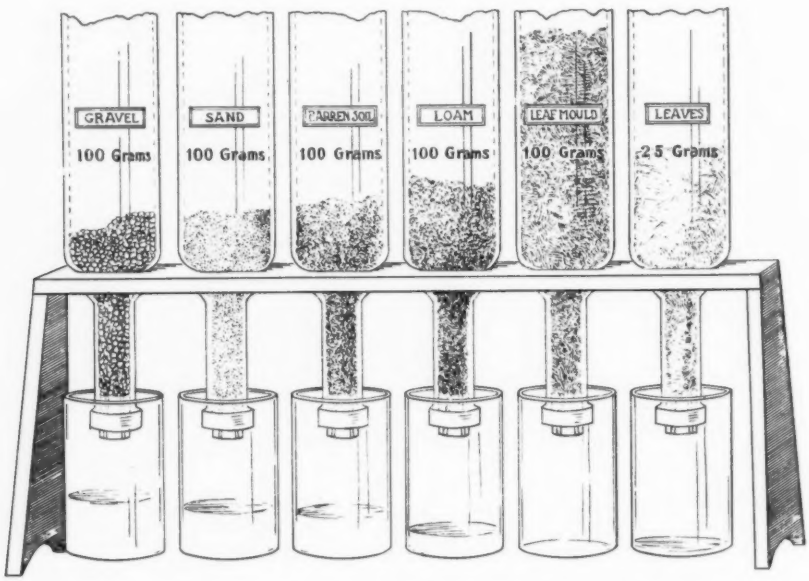

FIG. 24. THE ABSORBING POWER OF VARIOUS SOILS

Diagram to illustrate the relative amounts of water held by various kinds of soil and to show that leaf mould of the forest floor has greatest absorbing power

[1] One of the largest spring water companies in New York State has been reforesting its three hundred acres for several years to protect its springs and maintain the purity of the water and a regular supply. It reports planting 350,000 conifers consisting of larch, arbor vitæ, balsam, hemlock and various pines.

FIG. 28. MOUNT JEFFERSON, CASCADE NATIONAL FOREST, OREGON

The melting snows of mountains are absorbed and held by the surrounding forests as in a sponge, to be sent out slowly during spring and summer in an equalized supply to lower levels

FIG. 26. VIEW IN WINTER FROM MT. WILSON

If the forest is cut from foothills, their slopes, no longer protected by it and by a blanket of leaves and humus, must freeze solidly and remain frozen late; therefore, in spring, all the water in melting snow from the mountains flows over and down to lower levels without being absorbed,— wasted in damaging floods

lower levels without being absorbed,— wasted in damaging floods

FIG. 27. FARMING ON STEEP HILLSIDES

Scott's Creek, North Carolina. The lower slopes were cleared and cultivated till the soil was valueless; now the steep hillsides have been cleared and planted to corn. Soon all fertility will be washed out of the soil and the place will be abandoned. Forests instead of agricultural crops on steep slopes give continued returns while protecting adjoining lowlands from erosion and floods

' sponge" consists not only of the tree tops which form a close roof to keep out sun and wind, nor only of the layers of vines, brush, ferns, moss, dead leaves and humus on the ground (Fig. 24), but especially of the ground itself, which to a depth of many feet is a tangled interlacing of tree roots and of channels where formerly tree roots have been. Through such a forest sponge the water from winter snows and spring rains cannot penetrate rapidly but must gradually find its way to springs and brooks, producing a more or less equalized water supply to the surrounding region (Figs. 25 and 26). On the other hand, if the heads of watercourses are deprived of their forests, they allow the water to rush down the slopes, washing out the fertile constituents of the soil and producing floods in the lowlands,—a prodigality of water followed by lack in summer.

These facts are well illustrated in many places in the Appalachian region. Denuded slopes cleared for agriculture have yielded a profitable return for a few years; then decreasingly valuable because of the rapid eroding of the sloping fields, they served for pasturage a few years longer, then became wholly infertile (Fig. 27). This result in itself seems unfortunate enough, but consider the after-work of the rains that swept down these hillside farms (Fig. 28). It is said that in 1907 the floods from the onrush of one stream of this region (the Catawba River) caused a loss of a million and a half dollars' worth of farm buildings and stock.

Examine reports concerning the region of the Ohio Valley which, like the Appalachian region, possessed some of the finest broad-leaved woodlands of the country. Here farmers fought the forest for generations, regarding it wholly in the light of an enemy because the soil is fertile for agriculture. They cut the chestnuts, the walnut and hickory, the sycamore, elm and poplar, built log houses of the most perfect trees and burned the others. When demands for tanbark came they cut the oaks, sold the stripped bark and burned the logs in festival "log-rollings." At last they have produced a district well-nigh without woodlands, but at what cost! There are "mysteriously heaven-sent" blizzards and spring freshets; streams run almost dry in summer, and hot, drying winds scorch the crops; fruit-growing is continually more difficult. The price of timber has risen in unprecedented manner, while the tanbark supply is decreasing at such a rate, not only in the Ohio region but also throughout the country, that the total product in 1907 was 156,941 cords less than that of 1906.

Fortunately the damage to the nation's forests is not irreparable. Now that the country is known throughout its extent and careful estimates of its timber land have been made, now that the imperative necessity of forested uplands to control water supply is understood, there has come about a

FIG. 28. ONE OF THE DISASTROUS RESULTS OF A FRESHET

Sand deposited over alluvial bottomlands in Catawba County, North Carolina. This same flood caused the loss of a million dollars' worth of farm buildings and stock

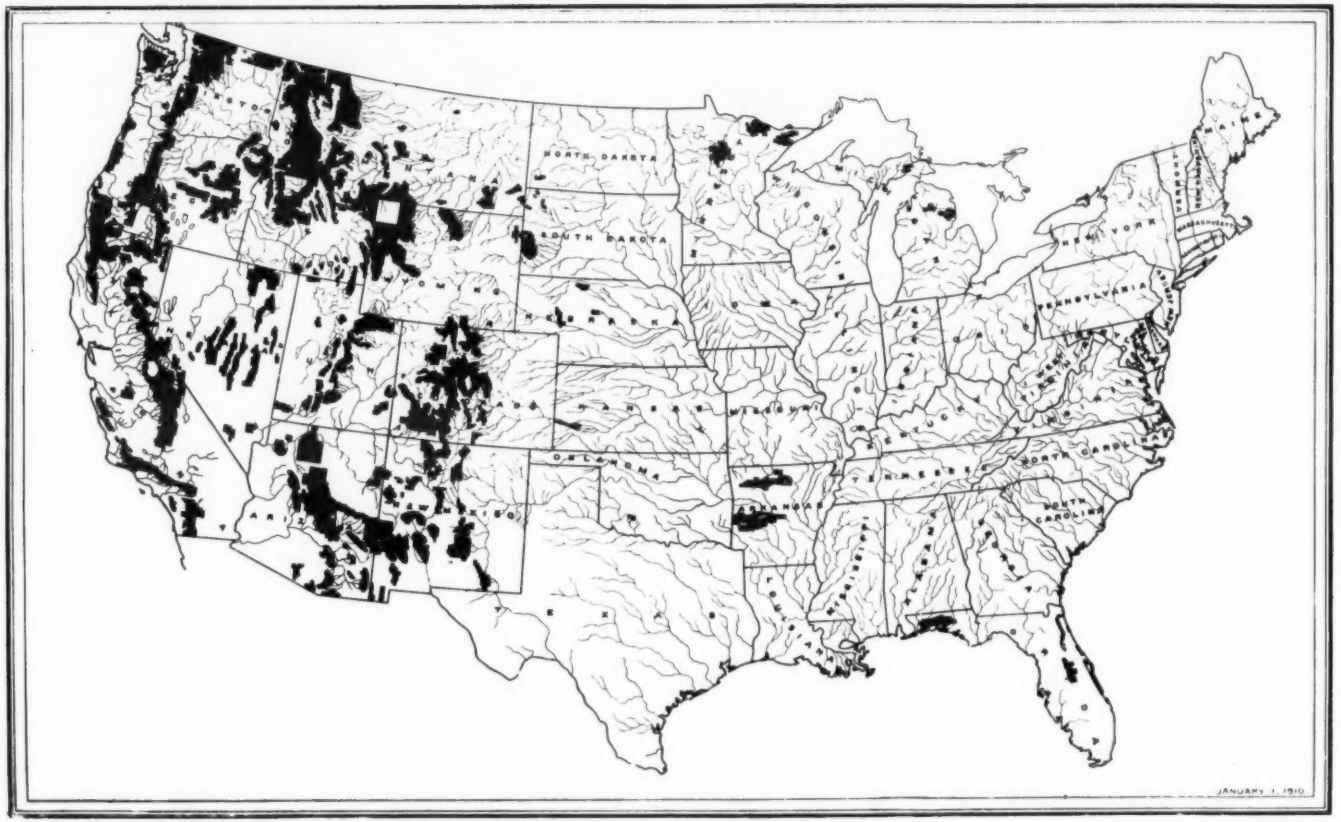

FIG. 29. NATIONAL FOREST RESERVES, JANUARY 1, 1910

Before the close of 1910, these reserves reached an acreage of about 196,000,000. For facts concerning the eastern reserves in the White Mountains and Appalachians, see note p. 35

sentiment for united effort in two directions: (1) conservation of remaining forests so that they will be made to yield a product without exhaustion to themselves; (2) reforestation of the heads of watercourses.

CONSERVATION OF EXISTING FORESTS

A LONG step was taken toward the conservation of forests when an act of Congress of March 3, 1891, authorized the President of the United States to set aside from time to time pieces of woodland for the benefit of the American people. Such reserves (Fig. 29), covering an aggregate of about 196,000,000 acres have been made by Presidents Cleveland, Harrison, McKinley, Roosevelt and Taft, and on February 1, 1905, the administration of these reserves was transferred to the United States Department of Agriculture, so that they are now under the care of experts in forestry. That the formation of national reserves is not a sufficient action, that the saving of the forests of the country still depends directly on individual and corporation owners rather than upon the nation, is seen by a comparison of acreage: the total extent of the reserves is one-third of the farm woodland of the country; it is insignificant when listed beside the millions upon millions of acres owned by railroads and by leaders in forest industries.

The work in conservation must be brought about by a coöperation that will result in legislation to bind the Nation, the States, all corporations and individuals. A move in the right direction was made when the Maine Supreme Court decided (March 10, 1908) that a state had the right to restrict the cutting of trees on private land, if the welfare of the general public was endangered by such cutting; also when Louisiana brought before the legislature a similar law, even more definite in its restrictions. By far the most important event in the movement in 1908 was the meeting of the Governors' Conference in May, followed by the joint Conservation Conference in December. Results cannot be obtained except through a union of the States;[1] the forests in Wyoming must be conserved to give

[1] The Weeks Bill:

To enable any state to coöperate with any other state or states, or with the United States for the protection of the watersheds of navigable streams, and to appoint a commission for the acquisition of lands for the purpose of conserving the navigability of navigable rivers.

This bill, the product of the combined study of some of the ablest men in Congress, is a general conservation bill for the creation of national forests. The immediate interest, however, lies in the Appalachian and White Mountain regions controlling the watersheds of the most important rivers of the East and the South and containing a great part of the timber supply.

The question of reserves for the East has been under discussion for ten years. The Weeks Bill itself has previously passed the Senate three times and the House once. In the sixty-first Congress it again passed the House, June 24, 1910; it was filibustered in the Senate, however, so that Congress adjourned without a passage of the bill. The Weeks Bill is scheduled to come up for Senate vote on February 15, 1911.

FIG. 30. A TRAP FOR FIRE

Clean out dead brush and dead trees and put into a condition to withstand fire

water to the dry plains of Idaho; forests in Colorado equalize the water supply in Kansas; the success of the great irrigation project in Nevada depends on the extent and condition of forests in California. Changes that may come in the near future, wholly to transform the situation, to encourage tree planting and to protect our forests, concern technical points such as taxation of forested land and trade relations with foreign countries.

A question comes from forest owners, "Is the fact that a forest is an investment consistent with conservation?" In answer, experts hold that there are common-sense forestry methods which, if employed in the management of any given woodland, will allow a man to cut his timber now, yet save or grow a better crop for a later harvest; that the value of his investment is increased, for it yields almost the usual immediate profit and a greater deferred gain. That the deferred profit will be great is due in part of course, to the annually decreasing supply of timber and the increasing demand, the yearly consumption at present being more than three times the yearly forest growth. One lumber company estimates that if, when a long-leaf pine forest is cut, twenty per cent of the stand be left, this will yield nearly half the original cut in twenty years,—a two per cent investment if there be no increase in value of timber in the twenty years, a ten per cent investment with the probable rise in value. Many lumbermen who bought long-leaf forests at fifty cents per thousand feet believe that in twenty years these forests will have a value of ten dollars per thousand at least. Dr. C. A. Schenck, formerly forester of the 125,000-acre Biltmore estate in

North Carolina, is quoted as selling white oak at fifty cents per thousand board feet in 1896 and receiving offers of eight dollars per thousand in 1904.

The care and reconstruction which will mean large pecuniary profit to forest owners, varies in different parts of the country and also in different woodlands of the same region, depending on the kinds of trees present, the condition of the forest and the proximity to market. In many cases the advice of a trained forester should be obtained (see p. 67).

SOME FORESTRY METHODS

IF WE enter a tract of forest in the East we are likely to find closely-growing second growths, sometimes chestnut[1] but as often sassafras, ironwood, dogwood, gray birch, red maple and other species of rela-

FIG. 31. LODGEPOLE PINES, 20 TO 25 YEARS OLD

A young forest in need of thinning and cleaning. Bitter Root National Forest, Idaho

[1] Since 1905 great ravages have been made among chestnut trees by a blight or fungus, *Diaporthe parasitica*. The forests of southern New England, of New York and New Jersey have suffered most, the estimate of loss being $10,000,000. So far the fungus yields its hold neither to known remedies nor to those newly tried and threatens to destroy all chestnut trees in the East.

tively small commercial value. There is little sign of the primeval growth of elm, hickory, hard maple, white oak, ash and white pine. Moreover many of these second growths are bent or broken, insect-infested, or burned and decaying at the base. The reforesting has been according to a wasteful and slow struggle for existence. It is possible that eventually the trees

FIG. 32. FOREST AT NEMO SOUTH DAKOTA

Cut stumps low and obliquely to shed rain. This will do much toward ridding the forest of breeding places for insects.

Americans no longer cut off an entire crop of 100 to 200 years' growth with no care for future crops. The problem is to bring a forest to its fullest producing capacity

dominant in the original forest might creep in and displace these, but the result would be a matter of many years. To turn such woodlands into profitable investments is the problem of their owners. Yet scientific forestry to-day is reported in practice on only seventy per cent of publicly owned forests of the United States, and probably on less than one per cent of those privately owned.

Certain fundamental suggestions are applicable to woodlands of any kind or size in any part of the country.

1. Clean out dead brush and dead trees, utilizing this material before it is wholly wasted, and also leaving the forest in a condition better to withstand fire (Fig. 30). Cut out insect-infested trees.

FIG. 33. WASTE IN CUTTING

Material left for insect breeding places and for fire. Black Hills National Forest, South Dakota

FIG. 34. PREVENTABLE WASTE

Fire lessens the productive capacity of soil and may set back young growth for a century or more

2. At the same time thin the forest to let in light and air (Fig. 31); leave the most promising trees (some for seed trees); cut out undesirable species, old trees no longer growing, spreading trees that overtop others of value, and perhaps, trees that grow slowly or that never attain large size. Thin only to such an extent that the crowns of the remaining trees will meet in three or four years; if greater thinning is resorted to, reforest in the open spaces, if only to prevent growth of grass and shrubs and drying out of the humus.

3. Cut all stumps obliquely to shed rain, also as low as possible (Figs. 32 and 33). These precautions will do much toward ridding the forest of breeding places for insects. See p. 63 in regard to sprout growth from stumps.)

4. In cutting and removing trees avoid injury to the seedlings and young trees. This is one of the most difficult and imperative of forestry laws.

5. Protect from grazing and from fire (Figs. 34 o 37).

If used for grazing, a wood lot rapidly decreases in reproductive power, for cattle or sheep are certain to destroy the seeds and seedlings of the ground as well as the trees of a few years' growth. If the woodland occupies a hillside, animals do much injury by loosening the herbage that holds the soil in place.

Forest fires have increased in frequency and destructiveness till they

FIG. 35. BURNED AND WINDTHROWN TIMBER

A hint of the terrible fire havoc in the Bitter Root Mountains, Idaho, 1910

demand national attention. Each new one of large proportions proves a national calamity. Conservatively estimated, the loss to new forest growth amounts annually to $90,000,000, leaving out the $50,000,000 waste of mature timber as well as the loss due to decreased fertility of the forest floor.

FIG. 38. FIRE IN VIRGIN WHITE FIR

Prattville, California. The problem of insurance of forest property at rates no prohibitive must come up for settlement in the near future

In case of large and isolated tracts of land, forest rangers must be employed;[1] in smaller woodlands, fire lanes, constructed to divide the forest

[1] Systems of telephone lines connected with outlooks have been found to facilitate greatly the work of these rangers.

Secretary of Agriculture James R. Wilson has signed an agreement with the Great Northern Railway Company and with the Northern Pacific Railway Company by which in the future the Forest Service and the railroads will coöperate closely in preventing fires in national forests adjoining the tracks of these companies.

into small tracts, will prevent the spread of a fire to disastrous proportions; everywhere and at all times care must be taken to prevent the starting of forest fires from camp fires and burning brush.

The aim of all such work is the improvement of the woodland, although there may result a considerable product for home use and sale. Such improvement, made even at odd times by a farmer without help, has been known to increase the value of the wood lot forty per cent. When the aim of a given cutting is a large product for market, still the forest should be left in an improved, undepleted condition, the cutting accompanied by reforesting. For this cutting and attendant reforesting, few general laws can be made. The method most practicable is the so called "Selection Method" by which selected trees here and there are cut, the owner always keeping in mind the kind of forest he wishes to have after the crop is removed. He must consider the trees remaining as to age, condition, tolerance for shade and market value of species. Sprouts or seedlings from near seed trees will soon fill up the opened spaces; or better still, young trees raised in seed bed and nursery may be planted and so the species fully controlled. By this method a very irregular mixed forest results, with trees of many sizes and kinds, capable of yielding varied products (see p. 52). Trees tolerant of shade (beech, maple, spruce and hemlock) can be made to fill in below

FIG. 37. DISASTROUS RESULTS OF FIRE

Although occurring twenty years ago, the fire has been followed by no young growth. Bighorn National Forest, Wyoming

those not shade-enduring, such as oak and hickory. The greatest difficulty in the management of a selection forest consists in not injuring young trees when getting out a crop.

If a forest consists of trees of relatively even size and age the "Strip" or the "Patch" method may be followed, in accordance with which one portion is cut clean each year. Of course, if a forest is to yield equalized annual incomes, it must consist eventually of as many sections, varying in ages from seedlings to the marketable size, as it requires years for the trees to attain marketable size. For instance, to yield annual crops of box-boards cut from white pine trees of thirty-five years' growth, a forest must consist of thirty-five sections; to gain annual crops of railway ties produced from catalpa trees fifteen years old, the plantation must have fifteen sections.

AIM OF WOOD LOT OR FOREST

THE aim of the wood lot or forest will be determined on (1) its conditions as to species and soil and (2) on the present and probable future market.

Soft Woods in Proximity to Pulp Mills

It is fortunate if a forest of soft woods (balsam, hemlock, spruce, Carolina poplar, aspen, cottonwood, willow, basswood, or tulip-tree) has a near market in the shape of a pulp mill. In 1907 there were used in the United States for the manufacture of paper pulp, 3,962,660 cords of wood, more by 300,000 cords than in 1906. Of this amount 2,700,000 was spruce wood, one-third of which came from Canada.

Trees for the pulp industry must be grown close together so that the trunks will be clear of branches, because first-grade pulp wood, which may bring as high as $10 per cord, is free from knots. Since a pulp mill uses very small pieces, even as small as 2 ft. by 4 in., much of the material taken out in thinning a woodland may be sold to advantage. Experiments in the future may prove that paper can be made from still cheaper material than wood, perhaps from annual plants of rapid growth, cornstalks or the stems of other tall grasses. Here, as in all questions of agriculture and forestry, landowners must study the markets.

In the case of pulpwood, it is especially true that conservation means not only maintaining a supply of raw material but also operating economically in the use of this supply. Timber waste must be used as pulpwood, clear logs sent to the sawmill and slabs, tops and imperfect trunks turned into pulp. This economy is forced upon us, particularly since Canada to protect

her own resources prohibited the exportation of unmanufactured wood (May 1, 1910).

Durable Woods, and Market for Posts

If conditions combine a market for posts and a woodland of durable woods such as cedar, white oak, Osage orange, catalpa, black locust, chestnut or mulberry, cypress or redwood (see p. 47 for treated woods serviceable for posts) the production of posts may be the aim, with reforesting by the sprout method (see p. 63) to gain rapid growth and frequent crops. It is the heartwood only that makes a durable post, so trees must be allowed to attain a diameter that will give a preponderance of heartwood, and naturally the best trees for the purpose are those in which the formation of heartwood follows rapidly on the growth of sapwood (see Fig. 6, p. 13). Reports from Ohio recommend honey locust for posts; if grown close in a good soil, it is said to produce straight, smooth posts more durable than even cedar or white oak.

Durable Woods, and Market for Ties, Poles or Piling

The cutting of durable woods may be deferred until the trees attain a size suitable for railway ties (trees 12 to 16 inches in diameter; also the upper logs of larger trees). About sixty per cent of all ties in use at present are white oak, but the white oak supply is now practically exhausted. In the Lake States hemlock and tamarack are being used. Chestnut sprouts reach size for railway ties in thirty-five years. Every mile of railroad requires 2500 ties and if these ties must be replaced every seven years, as previously, the demand means cutting clear one-half million acres of forest annually. It is reported that the Pennsylvania Railroad uses 620,000,000 ties in its system. This corporation has begun planting trees for production of its own ties: 3,482,186 trees have been set out; 290,000 seedlings were imported in 1908. More than 1,000,000 trees were planted along the railroad's right of way in 1909. The species are black locust, red oak and catalpa, also various conifers such as Scotch pine, white pine and Norway spruce. (See wood preservation, p. 47.)

If durable woods are allowed to grow until they cut logs 25 to 30 feet long (upper diameter 5 inches or more), they find sale as telegraph or telephone poles with a market value of from two to ten dollars per pole.

Chestnut poles may be grown in 42 years from sprouts and will give 12 years' service. Red cedar, which combines more valuable qualities for poles than any other wood, must pass out of use with the present supply since the posts are cut from trees 90 years old and last only about 15 years. Arborvitæ also is one of the most desirable timbers for poles but, like cedar, can be depended on only till exhaustion of the present supply since the tree is

FIG. 38. "OPEN-TANK METHOD" IN WOOD PRESERVATION

Experiments have proved that treatment of wood in a preservative fluid (coal-tar creosote) makes it resist decay in moist situations. This fact will revolutionize the market for posts, poles and railway ties.

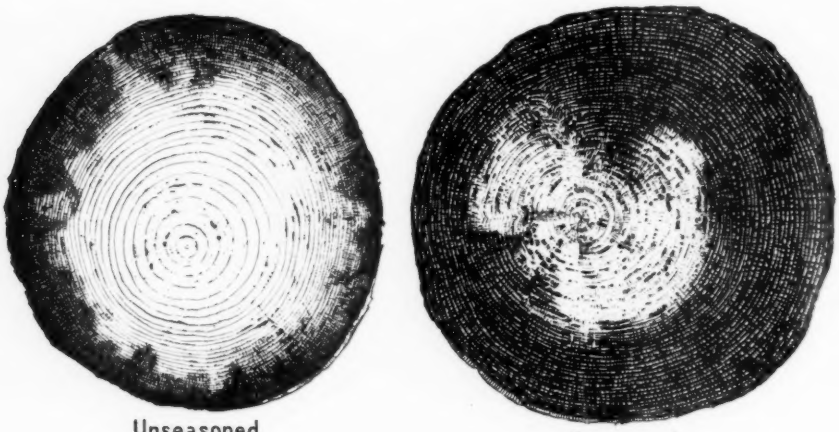

FIG. 39. COMPARATIVE SATURATION IN UNSEASONED AND SEASONED POLES

A partial vacuum must be created in the wood before the preservative fluid can be forced in; and since air can be expelled much more readily than water, seasoned timber is more effectively treated than green

extremely slow in growth. For piling, long-leaf, short-leaf and loblolly pine, white and red oak are used on the Atlantic Coast and the Gulf of Mexico, while Douglas fir supplies the demand in the Pacific region.

Under the waning supply of durable woods, experiments have been in progress which prove that the power of posts, ties, poles, mine and wharf timbers to resist decay in moist situations may be greatly enhanced by treatment in a preservative fluid. So successful has been the work that it is likely to revolutionize the market as regards these products. By treatment, not only do the durable woods gain a lengthened period of service but also less durable woods may be made to take the place of durable woods. The United States Forest Service states the following concerning fence posts: "Resistance of all treated posts to decay is alike, regardless of kind of wood used; posts with much sapwood take a deeper impregnation of the preservative." This means that the cheapest, least durable woods, like poplars, will come into service for posts, leaving the durable woods for use in interior finish and cabinetwork. According to the open-tank method of treatment (Fig. 38), formerly given the highest recommendation by the United States Forest Service, the wood is kept immersed in coal-tar creosote for a number of hours, depending on the kind of wood, and is then plunged into cold creosote, or is left in the cooling preservative over night. The wood should have been previously seasoned (Fig. 39) and its sapwood should be saturated with the oil. Brush treatment, by which the wood is painted with hot creosote, is less expensive, but also less effective because of the slight penetration by the oil (Fig. 40). Treatment in closed cylinders under pressure, is considered the best method as far as results are concerned, but it is five times as expensive as the tank method.

The effectiveness of the tank treatment lies in two facts, namely, (1) creosote oil protects the wood from the entrance of water and (2) creosote — being antiseptic — protects the wood from the attacks of bacteria and various fungi which grow rapidly in damp situations and whose growth means decay of the wood. The theory that insures the impregnation of the wood by tank process is as follows: heating in the creosote expands the air contained in the wood until much of it is driven out; plunging the wood into cold preservative causes the air left to contract leaving a partial vacuum which is filled at once by the cold oil forced in by atmospheric pressure (also by capillarity).[1]

Treatment of wharf timbers with creosote protects absolutely from marine borers (Fig. 41). Zinc chloride is used to some extent in treatment of woods but the resulting protection is not permanent because the preservative is soluble in water.

[1] The importation of 25,000,000 gallons of creosote into New York City in 1908 was an increase of 21,500,000 gallons over that of 1904. This indicates great development of wood preservation.

FIG. 40. BRUSH METHOD OF TREATMENT

Cheaper but far less effective than a saturation method

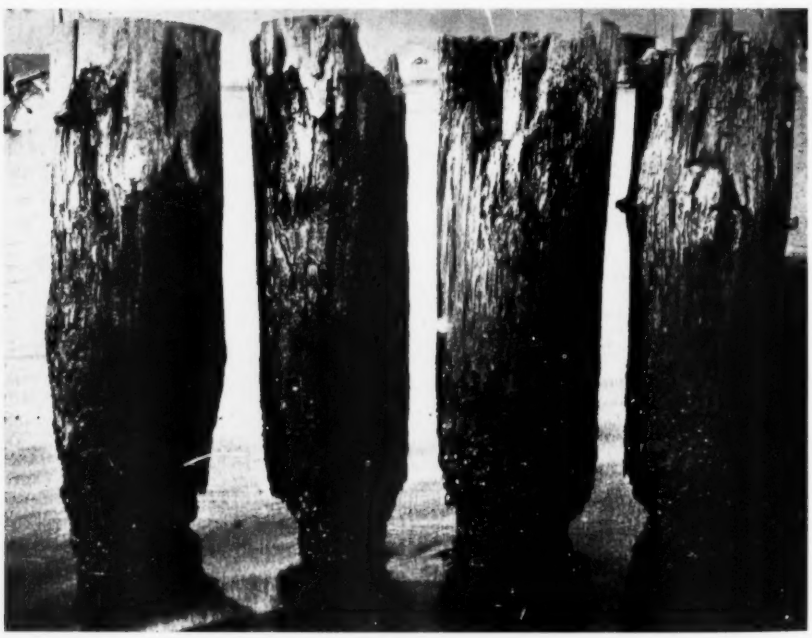

FIG. 41. DESTRUCTION BY MARINE BORERS

Piles at Norfolk, Virginia. Treatment of wharf timbers with creosote protects absolutely from such attacks

FIG. 42. BLACK WALNUT (*Juglans nigra*)

New England to Florida, Michigan to Texas. Wood hard, susceptible of a high polish, prized for cabinet work and interior finish. Forestry hall, Case G, 7–8

FIG. 43. VALUATION SURVEY AT WASHINGTON, D. C.

Foresters can estimate not only the amount of saw timber in a forest but also the posts, ties, poles and firewood over and above this timber. Conservation means utilization of the whole tree

FIG. 44. GUMPICKER'S CAMP

Spruce woods near Barneveld, N. Y. Gum gathered from the trunks of spruce trees is a paying by-product of the northern forest

FIG. 45 SUGAR MAPLES AT BURLINGTON, VERMONT

Maple trees may be tapped for maple sugar and still yield good timber

this timber. Conservation means utilization of the whole tree

Hardwoods and Cooperage

White oak and elms have been the standards for cooperage work which, like tanbark, entails great waste of material. Coopers have been forced into using beech, red oak, maple, ash and birch, especially for slack cooperage (barrels for dry materials). Logs grown for cooperage should be more than ten inches in diameter. Their market prices are unusually good.

Beech, Maple, Birch, and Acid Factories

In certain eastern districts acid factories demand large supplies of wood for distillation, preferably of beech, maple and birch (8000 cords per year). Some of the products of these factories are wood vinegar used in dye works; wood alcohol of special value in chemical works; acetic acid utilized as vinegar; and charcoal.

A Timber Forest and its Varied Products

If a woodland consists, or can be made to consist in the future, of valuable trees grown for timber from the seed, the owner can well make his aim the production of saw logs for quartered and other high-priced lumber which will find ready sale in home or foreign market. A timber forest may have a wood capital twenty-five times as large as that of a sprout forest. Some of the most valuable timber trees are black walnut (Fig. 42), black cherry, white oak, white ash, hickory, red oak and sugar maple. In a timber forest the distance of trees from one another is an important item: if too far apart, the trunks do not clear well and the lumber is knotty; if too close together, the trunks remain too small in diameter.[1]

A timber forest may yield many products besides high grade lumber.[2] A forester can estimate not only the saw timber in the trees to be cut but the number of posts, ties, poles and firewood over and above this timber (Fig. 43). More and more the entire timber is being used, proving one of the most effective methods of conservation. This complete utilization has been made possible by the establishment in many localities of charcoal

[1] See "Rules and Regulations for the Grading of Lumber," Bulletin 71, Forest Service, U. S. Dept. of Agriculture

[2] The following figures are of interest:

The United States uses annually
100,000,000 cords of firewood
40,000,000,000 feet of lumber
1,000,000,000 posts and poles
118,000,000 railroad ties
1,500,000,000 staves
133,000,000 sets of heading
500,000,000 barrel hoops
3,000,000 cords of native pulp wood
185,000,000 feet of mine timbers
1,250,000 cords of wood for distillation

FIG. 46. TURPENTINE FOREST OCILLA, GEORGIA

Long-leaf pine trees, if properly managed, may yield a turpentine product and have their timber value remain unimpaired. The Naval Stores industry of the United States in 1908 put out 36,500,000 gallons of turpentine and 4,000,000 barrels of rosin at a combined value of $32,000,000

blast furnaces and chemical plants to convert bark, limbs, edgings (Fig. 12) and even sawdust into some valuable product. If near a spool factory, birchlands may be profitable. Excelsior may be a paying product of mixed woodlands; the United States uses annually for excelsior 60,000,000 feet of timber (about 10,000 acres of forest). Each winter there is a large market for Christmas trees, especially near cities. Dealers estimate that New York City annually handles 125 carloads of Christmas trees, each carload containing 2000 trees. Large numbers of these come from the Adirondacks and from Canada. Gum picking may bring a considerable sum to dwellers near spruce forests (Fig. 44). The maple sugar and turpentine industries market "by-products" of a woodland without injuring its timber value, provided in the latter case that the trees are cut before injury comes to the chipped trees from insects or fungi (Figs. 45 and 46).

WORK OF FORESTATION

FORESTRY is of economic interest to landowners throughout the country, but planting trees in largest numbers must lie with the western farmer on prairie or newly-irrigated land. Each farm there, as well as in the East, should have its wood lot. In installing tree plantations in these regions, not only must fast-growing trees be chosen but also the young trees must be protected in nurseries until strong enough to endure exposure and until possessing top enough to shade the ground, for in summer the soil becomes dry. Greatest success has come in raising hardy catalpa trees (Fig. 47). A famous experiment with this tree was made on the Yaggy plantation in Reno County. The trees were grown from seeds and the seedlings were transplanted when one year old between rows of corn to the permanent site. One hundred and twenty acres were planted in 1890, eighty acres in 1891, two hundred and forty acres in 1892. Ten years' growth realized a net gain of $197.55 per acre, which amount will be greatly increased by a few years' delay in harvesting. Hardy catalpa is a species with known values in the present market, i. e. trees six years old produce posts valued at ten cents each; trees fifteen years old make ties worth fifty cents each, and two or more posts besides; trees twenty-five years old can be cut for telegraph poles which may realize fifty dollars each.

Tree planting is advisable as follows:

(1). In the forest where gaps made in thinning or in removing a crop

FIG. 47 PLANTED HARDY CATALPA, KANSAS

Catalpa attains size for posts in 8 to 10 years, for telegraph poles in 20 to 30 years. See p. 54

are so large that the crowns of the remaining trees will not meet and shade the ground within a short time.

(2). On rocky land with thin soil little valuable for agriculture.

(3). In wet places where no other crops will grow (Fig. 48).

(4). On hillsides too steep to plow (Fig. 45) especially if these slopes adjoin fertile fields and are subject to washing (Fig. 5). If a forest in such

FIG. 48. DISMAL SWAMP, SHOWING "CYPRESS KNEES"

The rich soil of swamp lands supports luxuriant growth. Giant cypress trees have been known to measure 40 feet in circumference.

A problem of the immediate future: to drain swamp lands north and south, plant forests, and incidentally better health conditions

FIG 49. SEED PLANTERS, ANGELES NATIONAL FOREST, CALIFORNIA

Trees should be planted on hillsides too steep to plow, in the East or in the West.

a situation is to serve a double purpose, namely, furnish a tree crop for market and protect agricultural land, it is best to plant nursery-grown stock to control the species and hasten the reforesting.

(5) Along sandy shores, or along mud banks of rivers and creeks. Such forestation is imperative when the watercourses run through fertile soil which washes away during fall and spring freshets.

In addition to a wood lot there should be shelter belts of trees to protect buildings, crops or stock feeding-grounds from prevailing winds. It is advised that not less than one-eighth of a farm consist of woodland. Along the exposed sides of a wood lot encourage the growth of a dense border of shrubs and low trees to protect the woodland from drying and to prevent windfalls. If a forest border is to be planted, choose a rapid-growing species, such as box elder, hardy catalpa or Carolina poplar, and one or more slow-growing species for later and permanent protection, such as any of the conifers.

No tree crop in the East is likely to prove more profitable than white pine, in the wood lot, on sandy shores, hilly fields or worn-out land. White pine reaches marketable size in thirty-five years, i. e. growing close (6 to 9 feet apart each way) and unpruned for box-boards. A tract of pine for high-grade timber should remain uncut for a somewhat longer period. Such a tract will increase its value greatly, even fifty per cent, if the trees

FIG. 50. EFFECTS OF EROSION, CATAWBA COUNTY, SOUTH CAROLINA

Trees should be planted on sandy slopes that lead down to fertile fields. Such trees will furnish a tree crop as well as protect the fields from erosion.

FIG 51. KNOCKING SEEDS OUT OF PINE CONES

Cleveland National Forest, California

are kept thinned and pruned. Such a cared-for tract may yield 25,000 B. M. per acre, five times the average yield of Michigan white pine forests.

The following figures are interesting for owners of New England abandoned farms:

Average cost per acre of land	$4.00
Average cost of raising and planting seedling white pines	4.84
Average taxes at 2 per cent for 40 yrs.	3.20
	$12.04
Compound interest for 40 yrs. making total cost	$50.99 per acre.
Average yield per acre box-board timber, 40 cords, at $4 per cord	$160
Net profit	$109.01 per acre.

from erosion.

GROWTH OF TREES FROM SEEDS

TREES in nature grow not only from seeds but also from stump sprouts and sometimes from cuttings (twigs broken from the trees during storms). Man's best method, with few exceptions (see p. 62) is to grow trees from seeds.

Obtaining the Seeds

Seeds may be purchased from nurserymen but the grade is not always reliable and the cost is high. If possible, collect the seeds for the immediate need. Collect thoroughly ripe seeds from well-grown roadside or field trees or from trees at the edge of the forest, remembering that as a rule the best and largest seeds produce the best trees. If seeds are obtained from a distance, the resulting trees will be hardier if the seeds come from a more northerly rather than from a more southerly section. Test the seeds by cutting open a few to see that the kernels are plump and moist. If desired make an absolute test as follows: plant some of the seeds in sphagnum or wet sand; cover the seeds their own depth and keep moist; the greater number of tree seeds germinate in from ten to thirty days.

Disposition of Tree Seeds for the Winter

Nature plants tree seeds soon after they ripen; the time of sprouting is another matter. Seeds that ripen in the spring are likely to sprout and make strong seedlings before winter; such are the elms and soft maples, poplars and willows. Of those that ripen in the fall, a few such as the white oak may grow before frost, but the larger number wait until spring. Among those that lie dormant one or more years are the linden, locust and red cedar.

Seeds should be removed from their cones, husks or pulpy coverings (Fig. 51) and then spread out to dry in the sun or in a warm room of the house. Dry only enough to prevent moulding; excessive drying destroys the vitality of the seeds. To insure for the winter the safe keeping of nuts and acorns and the smaller seeds, except those of conifers, arrange in a box in layers separated by layers of moist sand. Store this box in some cool cellar-like place or bury it in a shallow pit out of doors, heaping the soil above and further protecting from rain by boards. Seeds of pine, spruce and other conifers may be kept in boxes of dry sand, or in bags hung in a dry, cold place.

If a seed bed can be made in the fall, many seeds may be planted advantageously at that time. The loam of the ordinary garden bed serves well for broadleaf trees; conifers need a mixture of loam and one-third sand. The

seed bed should be spaded deeply and well fertilized with forest mould, phosphate of lime or well-rotted manure. Locate the seed bed on the north side of some building, fence or hedge so that it will be sheltered from too great sun. The seeds may be sown very thickly in drills 8 to 10 inches apart. Cover them about twice their own depth; seeds are often killed by deep planting. Cover the seed bed with a two-inch layer of chaff or of sphagnum or pine needles to keep the soil from drying. Before frost comes give the bed a thick protecting cover of hay or straw.

Spring Planting of Tree Seeds

If the seeds kept through the winter are to be planted in an out-of-door seed bed they should not be removed from their winter quarters until time for that out-of-door planting after the frost is out of the ground; but if they are to be started in flower pots or boxes in the house, they may be brought out and planted in February or March. They must be planted immediately on being disturbed. The surface of the earth in the flower pots or boxes should be kept moist by a layer of sphagnum or chaff, of crushed dead leaves or of pine needles.

Most tree seeds are slow in germination, beech, maple and oak requiring

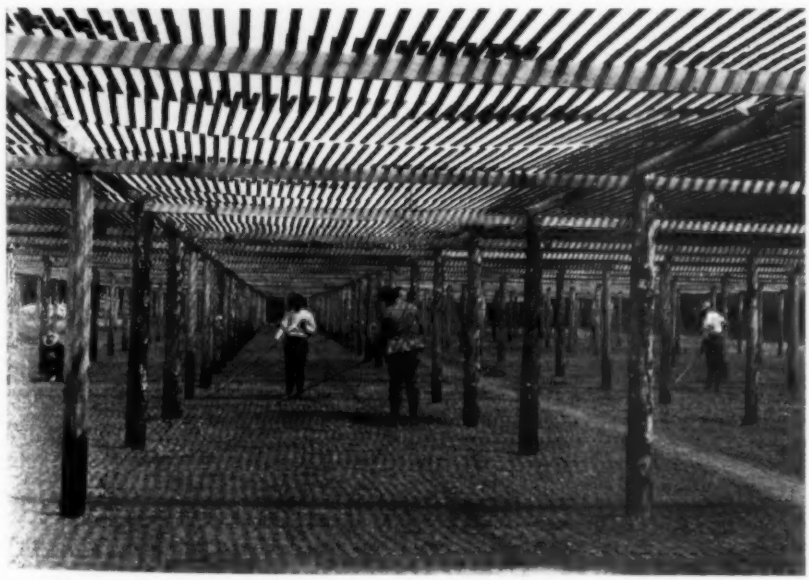

FIG. 52. COVER FOR SEED BEDS

In some instances, the cover is placed high enough to make a lath house in which those in charge can work, although a low cover is much to be preferred. Salt Lake National Forest, Utah

six weeks to appear above the ground, pine and spruce four weeks. Growth may be hastened by soaking the seeds twenty-four hours before planting. Seeds of linden and locust should have boiling water poured over them or should be soaked in hot water for three or four days.

How to Care for Seedling Trees

As a rule seedling trees grow very slowly their first year. Pines grow three inches or less, in fact, pines grow very slowly for the first five years and not rapidly until they are ten years old. Broadleaf seedlings grow faster than those of conifers; chestnut and a few others make the astonishing growth of fifteen to twenty-four inches their first year.

Seedlings grown in the house need the ordinary care given to house plants. If they are grown in the seed bed they must be kept partly shaded, and be protected from wind. It is suggested that a bed have a cover made of strips of lath, the width of a lath apart. This cover should be placed one foot or more above the bed, held on stakes driven into the ground at the corners of the bed (Fig. 52). A cover similar to this may be made of brush. Any cover should be movable so that it can be taken off on dark days. Conifers should be shaded for two or three years; broadleaf trees only during their first season.

Keep the soil of the seed bed loosened; also free from weeds. Thin the seedlings so that each will have light and air. For winter protection the row of seedlings should be banked with earth and the nursery bed covered with straw. For directions for transplanting see p. 64.

GROWTH OF TREES FROM CUTTINGS

WILLOWS and poplars may be grown from cuttings. Thus a quick method is provided for covering land to hold the soil along streams (cottonwood is recommended for irrigation ditches), and to prevent severe erosion from overflow.

The cuttings may be put into their permanent place at once or may be started in a nursery bed or in boxes. Considerable moisture is needed until the roots are formed. The usual cuttings are one foot in length and one-fourth to three-fourths of an inch in diameter. Plant with the buds pointing upward, and place three-fourths or more of the cutting underground. The soil must be closely packed above each cutting.

Good results are gained by making the cuttings in late fall and keeping them buried in sand in the cellar or in some out-of-door place till spring, then planting as described. This is like the natural method; that is, the winter winds may whip twigs from willow trees, these twigs may lie dor-

mant, only healing the broken place, and grow in spring, increasing the number of willows along river or swamp.

In the practical work of growing willows for basketry — a paying venture in the meadows and bottomlands of agricultural districts — cuttings are started in beds or boxes in the fall and transplanted in the spring. The farmer plows a long furrow, lays the cuttings in the furrow, then plows a second furrow to close the first; makes a third for cuttings, a fourth to close it, and so on, putting some 34,000 or more cuttings to the acre. (For details concerning willow growing and its financial returns see Bulletins 19 and 46, U. S. Forest Service; also Circular 148.)

GROWTH OF TREES FROM SPROUTS

BROADLEAF trees, in distinction from conifers, have the inherent tendency when cut down to sprout from the stump, that is, to form new buds in the cambium. As we should expect, this sprout growth is unusually rapid at first, fed by the perfected root system of the original tree; and trees possessing the sprouting power in large degree have great economic value. A forest of basswood, catalpa, chestnut, blue gum, black locust, soft maple, Russian mulberry, Osage orange or white willow

FIG. 53. PLANTATION OF BLACK LOCUST

This species is valuable since it thrives in plantations and has an extensive range. See p. 64

can be perpetuated for many succeeding crops of posts or poles, fuel, or small timber without renewal from seeds, but the sprouting power diminishes gradually with age.

To insure good sprout growth, the trees should be cut in winter or early spring and should be cut low. The stump must be as nearly level with the forest floor as possible so that it will be protected by a cover of leaves and snow and so that the sprouts may early form their own root systems. If the stump is a foot or more high, the cut surface should be oblique in order to shed the rain. All of the sprouts except three or four of the stronger ones should be removed at the close of the first season to give space and light for those remaining.

For hedges and windbreaks, Osage orange sprout trees are recommended. For production of fence posts in sprout forest, chestnut, hardy catalpa (Fig. 47), black locust (Fig 53) Russian mulberry and Osage orange are valuable. If the purpose of a wood lot is the production of posts, poles or ties, the sprout method is used even at the beginning; that is, at the close of the second year after the seedlings are in their permanent sites, they are cut back to the ground, then at the end of the next year all but one sprout is cut away; thus is gained a taller, straighter shaft than the seedling would have given. During the succeeding years these shafts are kept well pruned of low branches.

TREE AND SHRUB TRANSPLANTING

CHOOSE trees that are not too large and that are free from fungi and insects. The various maples and the American elm transplant easily and may be eight to ten feet high; but almost any forest tree can be safely transplanted if only three or four feet in height. Choose trees suitable to the given purpose as well as to the selected place, — lawn, school grounds, roadside, windbreak, or denuded forest. Have in mind, however, that any tree or set of trees may serve secondary purposes, i. e. the trees of a windbreak may eventually produce good timber or telegraph poles; trees valuable for the roadside may also produce nuts or valuable tree seeds, or may have flowers that yield large amounts of honey.

It will pay to transplant wild seedlings to a nursery bed, strengthen them there for one or more years, then transplant to a permanent site. They must be transplanted as carefully as the older trees and must be shaded at first, as are nursery-grown seedlings.

It is thought that the transplanting of certain trees, especially of oaks and conifers, is made more liable to failure by an interdependence that

exists between the trees' roots and minute fungi of the soil (Mycorrhiza). When a tree is transplanted, these fungi are largely left behind and are likely to be lacking in the new soil.

Time of Transplanting

Transplant on wet or cloudy days in spring, or in warm regions in fall, when the tree is without its leaves and before the buds have opened. As soon as the buds open, it is too late to transplant with best success, since the new leaves will very likely die and the loss may not be replaced quickly enough to save the tree.

In the case of evergreen trees, theoretically any season will serve for transplanting, since they never lose all of their leaves. Practically, however, the best time is spring, when the buds for the new year's growth have not opened and the soil is not frozen. Summer cannot be the best time, since evaporation from the leaves under the summer sun must be so rapid that the tree may be injured before the roots are properly at work (see below, for ball planting of evergreens).

Method of Transplanting

The secret of successful transplanting lies in removing the tree from the ground with roots as nearly unbroken as possible, and in *keeping these roots from drying*. Do not expose the roots to sunlight or wind even for a few seconds; cover them — and keep them covered till they are in the ground again — with wet sphagnum or wet cloths, or best of all put them at once into a pail or tub of thin mud. Small trees may be carried in a pail of mud from the woods to the planting site.

If desired, ball-planting may be practised, that is the roots may be removed in a mass or block of earth. Conifers are difficult to transplant, in that they never revive if there is any drying of the roots, therefore ball-planting is recommended for them. This is often accomplished in winter, in which case the transplanting is begun at the approach of freezing weather, the hole for the tree is dug in the permanent site and the removal of the tree started. The digging about the tree is done a little at a time to allow deeper freezing of the soil about the roots; the tree is not removed to the new site until all of the soil is frozen even at the bottom of the block.

The hole for a tree should be dug wide enough to take the roots spread out in their natural position, and deep enough to let the tree settle into the soil to a position similar to that it had before transplanting. The soil to be put back into the hole must be made free from lumps and stones, so fine that it can be sifted about the roots. There must remain no air spaces, where rootlets may die because they cannot reach food. If the soil

is not good growing soil, it should be enriched by the admixture of well-rotted manure.

Hold the tree perpendicularly in position and sift fine soil over and around the roots till they are covered, slightly lifting and lowering the tree in its place to allow the particles of soil to settle close under and about the rootlets. After this, fill the hole with shovelfuls of soil, treading it down firmly as it is put in. Fill to a little higher than the surrounding level to allow for settling. Use no water during the transplanting unless the ground is very dry, in which case, put water on by sprinkling or spraying after the soil is well packed about the roots.

Trim the top of the tree so that it will not greatly exceed the extent of the root system, which probably was reduced in the transplanting. This cutting away of branches is especially necessary if the transplanting is done late in spring when the tree is in leaf, for the evaporating surface must be reduced. It is best for both the latter reason and for relation to the root system that evergreens be cut back whenever transplanted.

Almost any young shrub one to three feet tall, depending on the kind, can be successfully transplanted if care is used to keep the roots moist. Nothing could be more satisfactory for massed effects at the sides of the home lawn or for the school grounds, than the wild shrubs from the roadside or the woods border. Such shrubs are laurel, witchhazel, elderberry, spice-bush, sumach, flowering dogwood, red osier, maple-leaved viburnum, thorn apple, barberry and many others.

In planting a mass of shrubs follow directions for tree transplanting except that the whole space must be dug up so as to set the shrubs two to three feet apart. Do not leave sod between the shrubs or allow grass to grow there later.

Transplanting Stock from the Nursery

A tree nursery needs the same situation, soil and preparation as a seed bed (see p. 60). If the soil is dry, wet thoroughly the day before the transplanting. For hand cultivation, plant in parallel rows 2 feet apart; for horse cultivation, the rows may be 3½ to 4 feet apart. Dig the trenches such depth as to allow transplanted seedlings to stand 1 to 2 inches deeper than they grew. Set conifer seedlings 4 inches apart in the rows, broadleaf seedlings 6 inches apart.

The important item here, as in all transplanting, is to avoid exposure of the roots to air for even a few seconds. As soon as the seedlings are out of the soil they should have moist earth, wet cloths or chaff thrown over them, or should be put into a pail or tub of thin mud. Leave plants in the nursery until 12 to 18 inches high.

Transplanting seedlings one or more times, from seed bed to nursery, from nursery to permanent site, strengthens the root systems by makin

them more compact, and the resulting young trees are more vigorous than those left undisturbed. The long tap roots of oaks and walnuts and of catalpa should be cut off at the first transplanting. Older plants in the nursery should have root pruning some time before the last transplanting, that is, a sharp spade should be thrust into the soil around and under the trees.

PLANTING GUIDE

Compiled from the reports of the United States Forest Service

REFER to the Jesup Collection of woods for facts concerning the character of the wood and the economic value of each species with its associate trees; also for maps showing natural range. It was the original aim of Mr. Jesup that architects, cabinet makers and others interested in wood, as well as those interested in growing trees as a commercial venture, might have a ready place of reference for getting acquainted with not only the well-known species of American trees but also the many others little known and appreciated in the lumber market.

A forester can tell the rate of growth of various trees and therefore can estimate the time that it will take a given species to reach merchantable size and the average product that it will yield per acre. He can foretell, as a result, whether a particular woodland will or will not give satisfactory returns under the existing conditions of taxation and with the possibilities of fire. The United States Forest Service advises free of charge any applicant with a problem for economic tree planting. Foresters study the conditions of the locality and give particulars concerning species to be planted, how to obtain the young trees and how to plant them and care for them. If the application comes from some region not previously studied by the Forest Service, it may send agents to examine the locality and prepare planting plans. In certain cases, this direct examination may be made free of cost even for large commercial undertakings, provided the work is of considerable experimental and educational value. (See Circular 22, United States Forest Service.)

The Australian eucalyptus is proving a valuable discovery for America. Forestry experts are studying the problem of its successful culture both in the Southwest and in Florida. Eucalyptus has unusual rapidity of development coupled with an all-round usefulness of wood, and under the right climatic conditions is likely to give commercial crops in a much shorter period than our native trees. More than 23,000 acres in California have been turned over to eucalyptus growing during 1909 and 1910.

Many of the trees in the following list are those about which the United States Forest Service has gained definite planting data through actual experience and which have been proved to give best results under artificial conditions.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Green Ash (*Fraxinus lanceolata*) CASE F, 10	Wood hard, strong, coarse-grained, somewhat inferior to white ash but often substituted for it. Used for agricultural implements, furniture and vehicles, posts and fuel. One of the most useful trees for windbreak or ornament.	Recommended for economic planting in the eastern half of the United States, also on the northern prairies and the semiarid plains east of the Rocky Mts., and on all irrigated western lands. Will thrive under adverse conditions, growing on dry sandy loam or stiff clay upland.	Nursery culture necessary. Transplant 1 year old seedlings (6–10 in. high) to permanent site. (Nurserymen's price $2 to $3. per thousand for seedlings). Cultivate till ground shaded. Pruning will increase value. Growth relatively slow. Post size attained in about 15 years. Height at maturity 60 ft., diameter 24 in.	Endures shade only moderately. Recommended for pure stands, spacing 4 by 4 ft.; or combined with box elder, hackberry, white elm, Scotch pine or red cedar (spacing 6 by 6 ft.) If planted pure, may be given an understory of wild plum, chokecherry or other shade-enduring low trees to keep out grass and weeds.	The more valuable white ash is to be preferred in moist regions. On abandoned timber claims in arid parts of Nebraska green ash has survived where nearly all other species failed.
White Ash (*Fraxinus americana*) CASE F, 11	Wood of great value; tough, elastic, fairly durable in contact with the soil, takes good polish and seasons without injury. Used as first-rank timber for furniture, interior finish, cars and vehicles, tools and agricultural implements. Good for fence posts. Favorite for ornamental planting.	Newfoundland to northern Florida west to Ontario and Texas. Recommended especially for the Ohio Valley, the region of the Great Lakes, and irrigated lands in arid western districts. Gains best growth in rich moist soil; in dry situations should give place to the more hardy green ash.	Transplant seedlings from nursery at end of first year (6–12 in. high). Young seedlings endure dense shade. Till the plantation for three years until the ground shaded. Growth relatively rapid under good conditions; post timber obtained in 10–15 years. Sometimes reaches height at maturity of 100 ft., diameter of 3–4 ft. Renew stand from stump sprouts which give more valuable wood than the original seed forest.	Only moderately shade-enduring. May be planted pure though it thrives when mixed with catalpa, Scotch pine, European larch, black walnut, black cherry or hackberry.	Must be watched for fungous parasites and insect enemies. Autumn foliage purplish brown.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Basswood (*Tilia americana*) CASE A, 5	Wood known as "whitewood," soft, straight-grained, and easily worked; not durable in contact with the soil. Used for general construction lumber, woodenware, paper pulp, trunks, carriage bodies. Desirable for ornament and in shelter belts.	Recommended for moist and well-drained soils in the northeastern States to the Ohio Valley inclusive.	Transplant 1-year-old nursery-grown seedlings. Space 5 ft. each way. Growth rapid during first years, about the same as in Norway maple and red oak. Little cultivation needed. At maturity height 80 ft. Renew plantation by stump sprouts.	Moderately shade-enduring. Pure stand recommended, also mixed stands with white or red oak, white elm, maple, hickories or with white or red pine.	European species less valuable and more liable to insect injury. Flowers valuable to bee-keepers.
Box Elder (*Acer negundo*) CASE C, 12	Wood soft and weak, light, close-grained. Used for woodenware, firewood, paper pulp, and an inferior grade of interior finishing and furniture.	Recommended for the treeless West from North Dakota to Texas. Will thrive in many soils but prefers deep, moist loam.	Transplant nursery-grown seedlings to permanent site when they are 1 year old (10–14 in. high). Space 5 ft. by 5 ft. or 4 by 6. Growth moderately rapid. Annual height increase 1–10 ft., diameter increase 1 in. Average height at maturity 40–60 ft., diameter 1–2 ft. Tree short-lived.	Shade-enduring, so may form a lower story combined with white elm, honey locust, black locust, green ash, black walnut or European larch.	Good for windbreaks and as street trees because of hardiness but inferior to many others in every region. Does not grow straight enough for posts and produces less firewood per acre than either cottonwood or willow.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Hardy Catalpa (*Catalpa speciosa*) CASE F, 26	Wood most valuable; light, elastic, very durable in contact with soil. Fence posts may remain sound thirty to forty years. Used in cabinet work. Has high value for fuel, posts, small poles and railway ties.	Recommended for economic planting on fertile lands of the Middle West, south of the 41st parallel. It grows well in the southern parts of Ohio, Illinois and Indiana; in Nebraska south of the Platte River; in eastern Kansas; and on irrigated lands in New Mexico, Colorado and Utah. Will not grow well on poor sandy or stiff clay soils.	1 lb. seed yields 12,000 seedlings. Transplant from nursery when they are 1 yr. old (12–14 in. high). Space 4 ft. each way. Growth most rapid. Annual height increase 2½ ft., diam. increase ¼ in. Post size may be reached in 8–10 yrs. Telegraph poles in 20–30 yrs. If entire seed forest cut for posts after 15–20 yrs., it will renew rapidly from stump sprouts.	Not shade-enduring, therefore pure forest recommended, or associates like Russian mulberry or Osage orange which will endure shade and so act as a "filler" to force pruning and straight growth of the catalpa.	In 1888 a ten-acre grove of hardy catalpa was planted at Pioneer, Iowa. In 1908 the grove consisted of trees 25–32 ft. tall, 4–10 in. diameter, worth $2,825.70 in posts. Catalpa plantations should be protected by a windbreak of hardier trees. The common catalpa is much less hardy, and less erect in habit.
Red Cedar (*Juniperus virginiana*) CASE N	Wood light, soft, of very fine and even grain, and very durable. Used for posts and poles, sills, railway ties, somewhat in naval construction; but chiefly for lead pencils, cigar boxes and chests. The pencil industry uses 125,000 trees annually.	Thrives as far north as Nova Scotia and Dakota, but reaches best development south of Ohio Valley. Recommended for economic planting especially in Plains States west of Mississippi.	Buy nursery-grown seedlings, or transplant wild seedlings to nursery till 10–12 in. high. Space 4 ft. by 6 ft. Height at maturity 50–80 ft., diam. 2–3 ft. Timber produced in 70–120 yrs.	Plant pure, or with Osage orange or honey locust for windbreaks.	Fragrance of wood utilized as insecticide. The western red cedar (*J. scopulorum*) and the southern red cedar (*J. barbadensis*) give wood of similar grade.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Black Cherry (*Prunus serotina*) Case D, 7-8	Wood light, hard and strong. It works easily and takes a beautiful polish. It has high value in cabinetmaking and interior decorating.	Reaches best development on rich, moist, well-drained land. Recommended for the moist slopes of the Appalachians, and west of Indiana through eastern parts of South Dakota, Nebraska and Kansas.	Use nursery stock from seed. Transplant 1 yr. old seedlings, spacing 4 ft. by 6 ft. Relatively rapid-growing and short-lived. Serves well as nurse tree for slower-growing trees. In 10 yrs. attains height of 23 ft., diam. of 6 in. Mature height 40–80 ft., diam. 3 or more ft.	Combine with box elder, green ash, white ash, silver maple or black walnut.	The wood of the cultivated cherry is not used in the United States. Black cherry has various local names, such as rum cherry, whiskey cherry, choke cherry and wild cherry.
Chestnut (*Castanea dentata*) Case K	Wood light, moderately strong, coarse-grained and elastic; works easily and is very durable. Used in cooperage; for posts, poles, ties and mine timbers; valuable in cabinet work.	Will thrive in dry sandy or gravelly soils. Recommended for planting throughout the East particularly in New England, New York, Pennsylvania, Maryland and the Ohio Valley. Will grow well also in the West on irrigated lands.	Plant 1 yr. old nursery grown seedlings (10–15 in. high), spacing 5 to 6 ft. each way. Grows rapidly; annual height increase 15–20 in. till 30 years old. Renew forest from stump sprouts every 25–35 years. Sprout trees grow more rapidly than seed trees and produce timber in many respects better.	Pure stands recommended renewed by sprout growth. If mixed, plant with white pine, European larch or with maples, ashes or oaks.	Chestnut poles, ties and timber are in great demand. **See note p. 37 on chestnut blight.**

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Coffeetree (*Gymnocladus dioicus*) CASE C, 17	Wood heavy, hard and stiff, coarse in texture, and durable. It works well and takes a good polish. Heartwood reddish. But little known commercially. Valuable for general construction work, for posts, for cabinetwork.	Recommended for commercial planting within its range, New York to west of the Mississippi, south to Tennessee. Also on the semiarid plains of Kansas, Nebraska, Oklahoma, Texas, Colorado and New Mexico. Reaches best growth in deep rich moist soil, but thrives in drier situations, enduring cold winters or hot winds.	Plant nursery seedlings 1–2 yrs. old. Rapid-growing under good conditions; annual height increase 1–2 ft.	Plant in mixture only, with white elm, red elm, hackberry, oaks or ashes. If given a few years start, may be combined with hardy catalpa, Russian mulberry, or black locust.	Valuable for general ornamental planting also.
Cottonwood (*Populus deltoides*) CASE L	Wood light and soft, not durable. Tendency to warp may be overcome by proper methods of piling. Used for fuel, paper pulp, box-boards, unexposed parts of furniture, interior woodwork. Produces a greater amount of fuel for a given period of growth than other trees.	Recommended for economic planting in watered regions of the Middle West. Especially recommended for the Ohio Valley. Is valuable on the northern prairies and the semiarid plains of the Middle West.	Start plantation from nursery-grown seedlings or from cuttings (latter cheaper). Rapid-growing; annual height increase 3–5 ft. for first 10–15 yrs.	Recommended for pure stands, and in mixture with shade-enduring hardwoods, or in moist situations with willow.	Valuable on uplands for windbreaks and along canals and streams to protect the land from overflow.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Slippery Elm (*Ulmus fulva*) CASE G, 3	Wood heavy, elastic, strong, moderately durable, works well. Used for furniture, for ribs of canoes and skiffs, for staves, hoops in slack cooperage, sleigh runners; also for fencing and fuel.	From the St. Lawrence to Florida westward to North Dakota and Kansas. Develops best in rich moist soils of valleys, but hardy in dry sites also.	Transplant 1 yr. old seedlings from nursery, spacing 4 ft. by 6 ft. Rapid-growing; 1 year seedlings 10–18 in. high.	Pure stands recommended. Good mixtures can be made with less shade-enduring hardwoods (white ash, green ash, hardy catalpa, locust or black cherry), or with the slow-growing black walnut, Scotch Pine and red cedar, if the elm is planted after the others have 5–6 yrs. start.	A more valuable tree than white elm. Because of rapid growth serves well as nurse tree for slower-growing species.
White Elm (*Ulmus americana*) CASE G, 4	Wood strong, tough and coarse-grained, not durable, difficult to work. Heartwood light brown. Used in slack cooperage, in shipbuilding, for flooring, wheels, agricultural implements.	In deep, fertile, well-drained soil, but thrives also under adverse conditions. Recommended especially for the Ohio Valley, for the semiarid plains of the Middle West and for the northern prairies.	Fairly rapid-growing and long-lived. Reaches height of 5–10 in. first year. Transplant from nursery when seedlings 1–3 yrs. old, spacing 6 ft. or less each way. Size at maturity, height 90–100 ft., diameter 3–7 ft.	Recommended for pure stands also in mixture with the more shade-enduring maples, ashes, and red oak or with black cherry, black walnut, yellow poplar and basswood.	Valuable in shelter belts and for ornamental planting. Known also as American elm and water elm. The cork elm, (*U. racemosa*) of Ontario and Michigan produces wood much stronger and heavier, used in bridge timbers and heavy agricultural implements.
Hackberry (*Celtis occidentalis*) CASE G, 2	Wood elastic, of medium weight, hardness, and strength. Used for cheap furniture. May be used as a substitute for elm and white ash; almost equals hickory for fuel.	Recommended for plains and prairies from Canada to Texas. Will thrive in sterile soil where almost any other tree would die. One of the best trees for the semiarid plains next the Rocky Mts.	Seedlings grow 6–12 in. 1st year. Transplant two year old seedlings from nursery, spacing 4 ft. by 6 ft. Mature growth 80 ft. high, 2 ft. thick. Tree lives 150–200 years.	Recommended for pure or mixed stands. Shade-enduring so can be made a lower story with cottonwood, walnut and ash, black locust, honey locust, or Osage orange.	Rivals white elm for shade tree in the Middle West. Good in mixture for windbreaks.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Shagbark Hickory (*Hicoria ovata*) CASE G, 8	Wood heavy, hard, very strong, tough, flexible, but not durable. Used for vehicles, agricultural implements, axe and tool handles; most valuable fuel; sprouts serve for barrel hoops and in basket making.	Recommended for good soil along the Ohio and tributaries and on fertile hillsides of the Appalachians. Does best in deep, rich, moist soil; will not thrive in hard clay or in sand.	Fairly slow-growing, comparing with white oak. Plant seeds in permanent site because of difficulty of transplanting seedlings (long tap roots). Space 6 ft. by 6 ft. First year's growth 6–9 in. Mature growth, height 120 ft., diameter 4 ft. Renew forest from stump sprouts.	Not shade-enduring. Recommended for pure stands or mixed with hemlock or maple, a lower story planted after the hickory is well started.	Wood in great demand bringing high prices. If trees are grown for nuts, space 20 ft. by 20 ft. Autumn foliage bright lemon yellow.
European Larch (*Larix europæa*) CASE M	Wood heavy, hard, strong, and flexible; very durable in contact with the soil. Largely used in shipbuilding. Very valuable for posts, poles and railway ties.	Recommended for commercial planting in Northeastern, Central and Lake States, to South Dakota. In Iowa, Arkansas and Nebraska it is one of the most promising of trees. Requires deep, well-drained, moderately fertile soil.	Transplant 2 yr. old seedlings from nursery, spacing 4 ft. by 6 ft. Most rapid-growing conifer in Northeastern States. Posts (3–5 in. diam.) grown in 9–16 years. Height at maturity 80–100 ft., diam. 2–3 ft.	Demands more light than other conifers. Do not plant pure. Mix with chestnut, white or green ash, white or slippery elm, Scotch pine, red pine, white pine, Norway spruce or red cedar. A mixture of three or four of these recommended.	Heartwood usually yellowish white, but when tree is grown in cold elevated situation, heartwood becomes reddish brown and harder.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Black Locust (*Robinia pseudacacia*) CASE C	Very tough, elastic and durable. Used for ribs of vessels, tree nails, insular shanks, and in vehicle construction. Equal to bur and white oak for fuel. Locust posts last 15–25 years untreated.	Recommended for any soil, except a wet heavy one, from the Atlantic to the Rocky Mts., south of the 38th parallel. Especially valuable for semiarid plains of Kansas, Nebraska, Oklahoma, Texas, Colorado and New Mexico, as well as for irrigated lands in Utah, Idaho, Oregon and Washington.	Transplant 1 year old seedlings (1–3 ft. high), spacing 4 ft. by 6 ft. (or 3 ft. by 8 ft. in Middle West). Short-lived but rapid-growing. Annual height growth 2–4 ft., diam. ¼–½ in. for the first 25–30 years. Height at maturity (50 yrs.) 80 ft., diam. 3 ft.	Requires much light. Plant pure, or increase the protective character of the stand by adding Russian mulberry, Osage orange or green ash.	Has been grown with success in California. Autumn foliage pure yellow.
Honey Locust (*Gleditsia triacanthos*) CASE C, 18	Wood heavy, hard and strong, coarse-grained; fairly durable. Used for fuel, fence posts, and poles. Most valuable for hedges and windbreaks and for general planting in treeless regions.	Recommended for deep, moderately good soils in Iowa, Nebraska, Missouri, Kansas, Oklahoma, Texas, Colorado and Wyoming. One of the hardiest trees for upland planting in semiarid regions of the Middle West.	Transplant 1–2 yr. old seedlings. Very rapid-growing. Grows 1–2 ft. high first year. Annual height growth, 1–2 ft., diam. ½–¾ in. Posts (3–5 in. diam.) grown in 8–14 years; at maturity height 75–100 ft., diam. 2–3 ft.	Will not endure shade. Give an understory of white elm, or mix with Osage orange, Russian mulberry and black locust.	Recommended as street tree. Equaled in drought resisting power only by Russian mulberry and Osage orange in the Middle West. Late in putting forth leaves. Autumn foliage pure yellow.
Silver Maple (*Acer saccharinum*) CASE C, 12	Wood light, not strong or durable. Works easily. Used for flooring, seats and cushion frame in cheap vehicles, flooring, furniture and excelsior. Plantations worth most for fuel.	Will grow anywhere in its natural range through the eastern half of the United States where there are deep soils in moist lowlands and river bottoms.	Short-lived and grows rapidly. Diameter increase ½–1 in. annually. Height at maturity 115 ft., diam. 3–5 ft. Transplant 1 yr. old seedlings which can be procured from nurserymen at very low rate. Renew stand by sprout method.	Somewhat shade-enduring. Plant in pure stand or mix with some ground shading species, such as black walnut, catalpa, white ash, black cherry or black birch.	Good for shelter belts and for park and street trees though there are better trees in every locality. Less hardy than cottonwood or box elder. Autumn foliage yellow.

Names and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Sugar Maple (*Acer saccharum*) CASE C, 10	Wood heavy, strong, hard, and dense; not durable; takes a fine polish. Used in cooperage, for implements and vehicles, for interior finish and furniture, for woodenware, spindles and novelties, for musical instruments. Has high value for fuel, charcoal and wood alcohol.	Anywhere within its natural range, the eastern half of the United States. Needs moderately rich well-drained soils. Especially recommended for the Ohio Valley.	Long-lived and relatively slow in growth. Seedlings grow 6–12 in. first year. Transplant 2 yr. old seedlings from nursery. Annual height growth 1 ft. till tree 30–40 years old. At maturity height 120 ft., diam. 3 ft.	Shade-enduring, therefore forms a good understory in plantations of rapid-growing trees. Plant pure or mix with white pine, red pine, white oak, red oak, shagbark hickory, chestnut, basswood or yellow poplar.	Its sugar value in economic planting is greater than its timber value. For sugar production, a pure stand, widely spaced is the rule. Autumn foliage red, yellow and green.
Russian Mulberry (*Morus alba tatarica*) CASE F, 20	Wood heavy, elastic coarse-grained, moderately strong, durable. Has high value for posts and fuel.	Recommended for economic planting in rich loam, sandy or clay soils in southern Nebraska, southern Iowa, Kansas, and Oklahoma. Especially good results obtained in the Ohio Valley. Valuable for windbreaks; recommended for silk culture.	Plant nursery-grown seedlings, spacing 4 ft. by 4 ft. Growth fairly rapid, attains height of 20 ft., diameter of 8 in. in 10 yrs. Fence posts produced in 9–15 years. Height at maturity 30–40 ft., diam. 1 ft. Renew stand by sprout method.	Plant pure, close and keep pruned for posts and fuel. Shade-enduring, therefore good for underplanting with black locust, honey locust, black walnut and green ash.	Will endure almost any amount of drought and neglect. Cannot endure cold winters. This tree is a hardy variety of the Asiatic white mulberry introduced into the United States in 1875.
Bur Oak (*Quercus macrocarpa*) CASE J	Wood heavy, hard, strong and durable; not distinguished from white oak in the markets. Used for posts, railway ties, and the purposes served by white oak.	On good soils anywhere east of the 98th meridian and in deep rich river bottom soils farther west. Recommended only for rich, moist, well-drained soils.	Slow in growth, like the white oak. Not easy to transplant because of long tap root, therefore, plant acorns in the permanent site; spacing 4 ft. each way. Greatest height at maturity 170 ft., diam. 7 ft. Renew stand by stump sprouts	Not shade-enduring. Recommended for pure stands or in mixture with still slower-growing species which will force the oaks to taller growth.	One of the most valuable of the hardwoods. Highly desirable for ornamental planting.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Red Oak (*Quercus rubra*) CASE J	Wood heavy, hard and strong, coarse-grained, moderately durable; not so strong or so durable as white oak, but more easily worked. Used for cabinetwork and interior finish. Not distinguished from white oak in the markets.	Recommended for economic planting on well-drained soils of medium quality or exhausted by cultivation, anywhere in the Northern and Central States.	Grows more rapidly than any other oak. Transplant 1 yr. old seedlings from nursery or plant acorns in permanent site. Height at maturity 150 ft., diam. 5 ft. Renew stand from stump sprouts.	Cannot endure shade. Plant pure or with slower-growing trees such as other oaks, or sugar maple, white elm or white pine. If planted in mixture with chestnut or hickory give it a start of 2–3 years.	By treatment becomes more valuable than white oak for cross ties. Red oak and scarlet oak (*Quercus coccinea* Moench) are highly recommended for use as street trees. Autumn foliage red.
White Oak (*Quercus alba*) CASE J	Wood strong, heavy, hard, tough, close-grained, very durable. Used in ship building, heavy construction work, tight cooperage, vehicles, farm implements, ties, posts and piling, as well as for interior finish and cabinetwork.	Recommended for artificial planting in the eastern half of the United States; especially successful on the lower slopes of the Alleghanies and in the Valley of the Ohio. Can stand drought and cold but thrives best on rich, moist, well-drained loam in protected places.	Slow-growing, diameter increase in ten years in the forest 1 in., in plantations something greater. Height at maturity 60–100 ft., diam. 2–4 ft. (grown under average conditions). Transplant 1 yr. old seedlings from nursery, or plant acorns in shallow furrows or holes in permanent site. Renew by sprout method for ties or posts.	Will not endure shade and does well planted pure. May be mixed with red oak, shagbark hickory, mockernut hickory, chestnut, black walnut, yellow poplar, white elm, white ash or white pine.	Wood of great economic value, and has been so generally used that the supply is nearly exhausted. Valuable street tree. Autumn foliage red and russet brown.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Osage Orange (*Toxylon pomiferum*) CASE F, 20	Wood heavy, tough, hard and strong. Used for railway ties, machinery, wagon felloes, insular pins, tool handles. Most valuable for hedges and windbreaks.	Recommended for economic planting in the middle western states from central Illinois southward and westward to eastern Colorado and New Mexico. Will stand aridity, therefore especially valuable for planting on the semiarid plains east of the Rocky Mts.	Grow seedlings or purchase from nurserymen ($1 to $3 per thousand). Equals Russian mulberry in rate of growth but falls behind black locust. Posts (3–5 in. diam.) produced in 7–11 years. Height at maturity 60–70 ft., diam. 2 ft. Renew by stump sprouts for posts or fuel.	Endures shade, therefore can be made to occupy a lower story in a mixed stand with black walnut, black locust, honey locust or green ash.	Surpassed in hardiness only by red cedar. A 10-acre tract was planted at Farlington, Kansas, in 1878. In 1900 it yielded a total value of $524.04 per acre. The land could scarcely have been used to bring better returns.
Jack Pine (*Pinus divaricata*) CASE O	Wood light, soft and coarse-grained, fairly strong and fairly durable. Good for coarse lumber and posts and for ties when treated.	Recommended for north Central States where soil is sterile or sandy but supplied with moisture not far below the surface. Very hardy, growing with success where few other trees will grow.	Short-lived and one of the most rapid-growing of the pines. Transplant seedlings 2–3 yrs. old, spacing 4 ft. by 4 ft. Height at maturity 60–90 ft., diam. 2 ft.	Not shade-enduring. Plant pure or mix with green ash or hackberry which will not overtop it.	Somewhat inferior to red pine and to western yellow pine. Valuable for windbreaks.
Red or Norway Pine (*Pinus resinosa*) CASE O	Wood heavier, harder and stronger than white pine, only moderately durable. Used for house lumber and, when treated, for posts, ties and mine props.	Recommended for economic planting in northeastern part of the United States in situations suitable for white pine.	Transplant nursery-grown seedlings when 3 yrs. old, spacing 4 to 6 ft. apart each way. Growth fairly rapid. Attains height of 35 ft., diam. of 6 in. in 30 years. Height at maturity 90 ft., diam. 2–3 ft.	Light-demanding. Plant in pure forest or mixed with trees of slower growth, such as chestnut, red oak, sugar maple or European larch.	If planted close, clears well of lower branches without pruning. Compares with western yellow pine in characteristics of the wood.

Name and Location in Jesup Collection	Economic Value	Where to plant	Growth	Associate Trees	Remarks
Scotch Pine (*Pinus sylvestris*) CASE P	Wood strong, elastic, close-grained, works easily; not durable in contact with the soil. Used as fuel, for staves and heading in cooperage, box-boards and general construction work; when treated, suitable for railroad ties and mine timbers.	Scotch pine thrives in a dry atmosphere which fact recommends it for wide planting as a substitute for white pine. Recommended for northeastern United States and especially for the prairie states such as Nebraska, Iowa and Kansas.	Transplant from the nursery when seedlings 3 yrs. old (9–12 in. high), spacing 4 or 5 ft. each way. Growth fairly rapid. In Europe attains at maturity height of 120 ft., diam. of 3–5 ft. Yields mine timbers in 30–40 yrs.	Light-demanding. Plant pure, or mixed with trees that grow more slowly or demand less light. Combinations with European larch, Norway spruce, white pine and red pine are recommended.	More intolerant of shade than any of our native trees except aspen, birch and the larches.
Western Yellow Pine (*Pinus ponderosa*) CASE P	Wood light, strong and dense but only moderately durable. Used more extensively than any other wood of the Rocky Mt. region for lumber, railway ties, mine timbers and fuel.	Especially recommended for planting in the sandhill regions of western Nebraska and Kansas, and in the watersheds of the Rocky Mts. and the Pacific Coast below 6000 ft. elevation.	Transplant nursery-grown seedlings. They should be 2–3 yrs. old, having previously had some root pruning and transplanting. Growth fairly rapid. Height at maturity 200 ft., diam. 6 ft.	Recommended for pure stands.	A hardy pine, enduring many kinds of soil and climate. The wood is the most valuable of that produced in the Rocky Mt. region.
White Pine (*Pinus strobus*) CASE P	Wood soft, light, straight-grained and easily worked. Used in naval and general construction work but now largely superseded by other woods because of its scarcity. Second growth white pine is used for box-boards, pail staves, matches and woodenware.	Recommended for economic planting on non-agricultural lands of New England, Pennsylvania, New York, the Lake States and the higher slopes of the Appalachians. Will thrive on dry sands or on medium heavy clay and loam soils.	Transplant 3 yr. old seedlings from nursery (6–9 in. high). Annual diam. increase ¼–½ in. Height at maturity 150–175 ft., diam. 3–5 ft. Thin stand when 20–30 yrs. old. Box boards produced in 30–40 yrs.; saw timber in 60–70 yrs.	Plant pure or mixed with trees of slower growth, or less light-demanding, such as chestnut, European larch, Norway spruce, red oak and sugar maple.	Especially recommended for reforesting the abandoned farm lands of New England. (See p. 59) White pine trees may live 250 years.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Yellow Poplar or Tulip-Tree (*Liriodendron tulipifera*) CASE A, 3	Wood light, soft, tough and of fine texture, but not strong; fairly durable. Used for boxes, toys and woodenware, wagon boxes and carriage bodies, slack staves and heading, siding, paneling, interior finish, backing for veneer. Valuable for wood pulp.	Recommended for planting in Tennessee, Kentucky and western Carolinas, also in the Valley of Ohio and its tributaries. Yellow poplar attains its best growth in deep, fertile, well-drained soil having a constant supply of moisture.	Nursery-grown seedlings give best results, transplanted to permanent site when 1 yr. old. Young trees endure shade. Rapid-growing and long-lived (300 yrs). 1–2 ft. is the annual growth for first 40–50 yrs.	Will not endure shade and not strong enough to be planted pure. Combine with slow-growing trees (or give the poplar a few years start), with white pine or Norway Spruce or with a shade-enduring hardwood.	Often used where formerly white pine served. "White" poplar of the lumber market is the wood of trees grown on dry gravelly soil. Highly recommended for shade and ornament. Autumn foliage pure yellow.
Norway Spruce (*Picea excelsa*) CASE N	Wood light, soft and non-resinous; works well and is fairly durable. Used for construction timber, fuel and wood pulp.	Will thrive in a shallow soil and dry climate. Recommended for the Northeastern and Lake States, also for cut over lands of the North and for the northern prairies.	Transplant seedlings 2–3 yrs. old. More rapid-growing than native spruce. Height at maturity 80–100 ft., diameter 2–3 ft.	Pure stands recommended; or mix with white or red pine, with European larch or chestnut.	Serves as a substitute for white pine. Extensively used as an ornamental tree.
Tamarack (*Larix laricina*) CASE N	Wood hard, coarse-grained like red pine but stronger and stiffer; durable. Used for posts, ties, telegraph poles, canoes, spars and masts.	Will endure cold, wet situations. Recommended for planting throughout the northern states from the Atlantic to the Mississippi (up to elevation of 4000 ft.).	Grow seedlings in nursery beds, transplant when they are 2–3 years old. Rapid-growing. 45 feet height growth in 30 years.	Plant pure, or mixed with sugar maple or red oak or with spruce, balsam fir, or white pine.	The red tamarack of the market is the wood of trees grown on cold unfavorable sites.

Name and Location in Jesup Collection	Economic Value	Where to Plant	Growth	Associate Trees	Remarks
Black Walnut (*Juglans nigra*) Case G, 7-8	Wood heavy, hard, strong; works well and takes a good polish; durable. Used for furniture, cabinetwork and interior finish especially in churches; for gunlocks, tool handles, carriage hubs; somewhat in ship building.	One of the most valuable of North American trees for planting in the fertile vallevs of the Ohio and Mississippi and in the bottomlands of North and South Carolina, Georgia, Tennessee, Kentucky, Missouri, eastern Nebraska, Kansas and Oklahoma.	Transplant 1 yr. old seedlings from nursery; none but nursery method sure. Growth fairly rapid; 12–14 in. first year; post size in 10–12 yrs. saw timber in 40–60 yrs; May have annual diameter increase of 1 in. Bears fruit in 12–14 yrs.	Not shade-enduring. After the trees have 2–3 yrs. start, underplant with hardy catalpa, hackberry, Osage orange or box elder, shade-enduring trees which can be cut out in 20–25 years leaving the walnut to mature for saw timber.	Black walnut saw logs are exported to Europe, the best bringing very large returns. Autumn foliage bright lemon yellow.
White Willow (*Salix alba*) Case L	Wood soft, light, flexible, fairly strong and durable. Used in slack cooperage; for charcoal used in gun powder manufacture; for cricket and baseball bats; for fuel where wood is scarce. Willow posts and poles last only 4–7 years unless treated.	White willow has proved successful for economic planting in rich sandy loam through the northern states south to Virginia and west to Kansas and the Dakotas. Especially recommended for the Ohio Valley and the Northern prairies.	Plant cuttings, spacing 2 or 3 ft. by 8 ft. Rate f growth depends on site, never as great as that o cottonwood. In lowlands, annual height growth 3 ft., diam. 1 in.; on uplands height growth 1½ to 2 ft., diam. ½ to ¾ in. Renew stand from stump sprouts.	Recommended for planting pure or in mixture with cottonwood. Best adapted for holding soil along streams (not along canals or irrigation ditches because the roots grow into the water).	Recommended for windbreaks. Willow produces 2–3 cords of firewood per acre annually on bottomlands. Autumn foliage yellow.

ARRANGEMENT, SELECTION AND CARE OF LAWN AND STREET TREES

WHEN planting trees about the home, arrangement and selection must be considered from other than the economic standpoint. For instance, instead of scattering trees over the lawn and grounds, it is better to mass them on two or three sides of the buildings as a frame for a picture, leaving open space centrally. In this, dense effects may be produced by filling in a lower story with shade-enduring trees or shrubs such as beech, sassafras, dogwood, witchhazel, tupelo, hornbeam and birch. Consider the view and plant no tall trees in position to obscure it. If the grounds are large, little mistake can be made if the picturesque effects of natural forestation are followed; that is, if a brook passes through the lawn droop willows over it, or if there is a small lake fill a point of land with them. If there is a rocky slope make it beautiful with hemlock and beech. Group birches so that they will be set off by a background of dark tree trunks or of evergreens (Fig. 54); plant the low ground-juniper in open stretches. Lombardy poplars add a conventional touch to the scene; locusts distract from the formal. An occasional isolated tree may be effective; oaks, elms, beeches, maples and many others make luxuriant growth when standing alone (Fig. 55). Add some evergreens in all artistic planting if only for the effect in winter. (Frontispiece.)

Plant many trees in cities. They not only give moisture and coolness to the air but also actually make it more fit to breathe by taking out its carbon dioxide and increasing its supply of oxygen (see Fig. 17, p. 20). Trees in congested city neighborhoods tend directly to diminish the summer death rate among children.

In planting along city streets the conventional row must be followed; but on country roads a more natural arrangement should prevail, groups of trees alternating with spaces left open for distant views. Mass tall sun-loving trees with lower shade-enduring trees or with shrubs, and in places allow wild grape and shrubby bittersweet to add their artistic presence. Why conventionalize country roadways? Conformity to the conventional must exist in most that greets our eyes — in city streets, in agricultural fields, in tree plantations. A country roadway may be orderly and yet have a natural arrangement of trees and shrubs, which will have the advantage also of making the place a more attractive rendezvous for our native birds.

FIG. 54. DECORATIVE BIRCHES

On the estate of the late Morris K. Jesup, Lenox, Massachusetts. Plant birches so that they are set off by the dark trunks of other tree or by evergreens

For street planting, deep-rooted trees, like sugar or Norway maple, liquidambar or tupelo are best. They suffer least from having their roots covered by the solid substance of walks and roadbeds. Choice should fall more often on oaks for city streets; they take longer to attain large size, but the result pays for the waiting. Silver maple is often used, but like the box elder is fragile in storms and is short-lived. Some of the best trees for broad thoroughfares in the eastern United States are American elm, tulip-tree, tupelo or pepperidge, honey locust, sycamore, sugar maple and scarlet oak. Tupelo and scarlet oak in autumn are particularly attractive because of their brilliant red foliage. Asiatic trees much used for streets and lawns are ginkgo, horsechestnut, ailanthus and the magnolias. They are worth the attention they receive, except the ailanthus, which, however, has the advantage of growing under extremely adverse conditions.

Very often a sort of care can be given to shade and street trees impossible in the forest and under the conditions of economic forestry. They can be kept in good health, pruned, kept wholly free from insects, supplied with fertilizer and with the proper amount of water, and even artificially strengthened. In pruning, it is best to remove not only dead branches but also living ones to such an extent that there will be left space for the suitable development of those remaining. In removing a branch, cut close to the trunk so that the bark can grow over the wound quickly, preventing the commencement of a cavity through the decay of a stub. Cut through the bark below and at the sides first so that there will be no unnecessary stripping off of bark when the branch falls. If trees are artificially watered, avoid keeping the ground continually wet, but let it dry out between times. When roots are surrounded by water, oxygen cannot reach them, and if this condition continues, the trees die from their inability to breathe. A method has arisen in "tree surgery" by which hollow tree-trunks are filled with cement, all dead wood being first cut out and the cavity coated with antiseptic. There is no doubt that the process may lengthen the life of a tree tens or scores of years. Many great elms, the pride of Concord, Massachusetts, are interesting examples of such treatment.

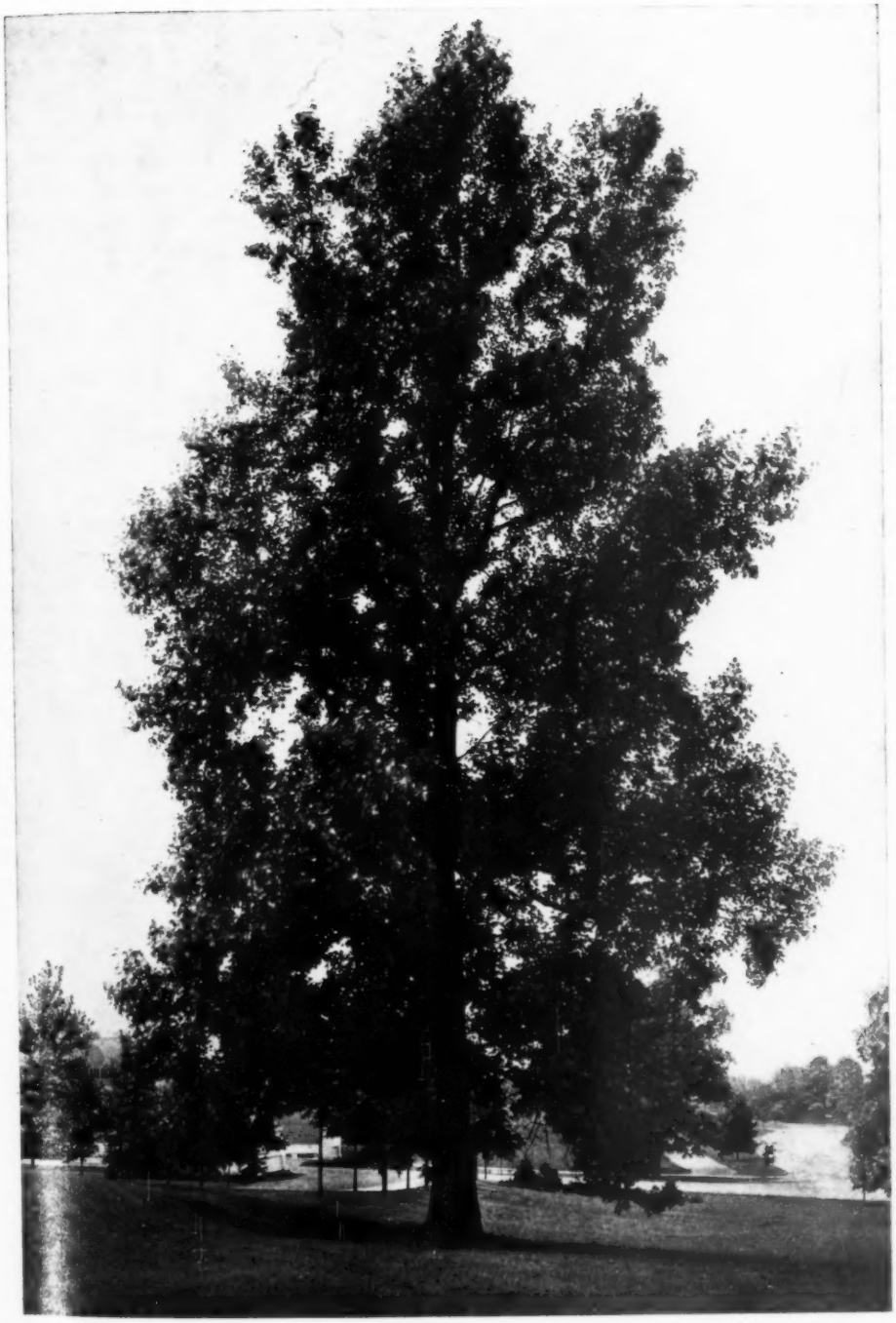

FIG. 55. TULIP-TREE IN NEW YORK BOTANICAL GARDENS

Many trees make luxuriant growth when standing alone. The largest tulip-trees known have measured 190 ft. in height and 10 ft. in diameter. This species cannot endure shade and in the forest prunes itself of side branches. Forestry Hall, Case A, 3

APPENDIX I.

HOW TO RECOGNIZE A FEW EASTERN BROADLEAF TREES IN WINTER.

Artificial Key to the Twigs.

A. Twigs with alternate buds
  B. Twigs with dark bark.
    C. More or less slender and flexible:.....I pp. 86 to 91.
    CC. More or less stout and stiff:.....II pp. 91 to 93.
  BB. Twigs with light bark.
    C. More or less slender and flexible:.....III pp. 93 to 95.
    CC. More or less stout and stiff:.....IV pp. 95 to 97.
AA. Twigs with opposite buds.
  B. With dark bark:.....V pp. 97 to 98.
  BB. With light bark:.....VI pp. 98 to 99.

I. *Beech, Chestnut, Wild Cherry, Birch, Alder, Elm, Linden and Locust: Trees whose slender and flexible twigs have alternate buds and dark bark.* The twigs of these trees resemble one another closely and are more difficult of recognition than all others.

1. **Beech** (*Fagus americana* Sweet). Beech twigs are known by their unusually long and slender, pointed buds which have many overlapping scales (Fig. 56). The twigs are smooth and reddish brown, and are bent at the points of attachment of the buds. The tree is recognized also by the clean and smooth gray bark of the trunk.

2. **Chestnut** (*Castanea dentata* Borkh.). Chestnut twigs of recent growth have strong ridges extending downward from the leaf scars (Fig. 57). The rounded buds are light brown, have few scales and extend from the twig at an angle of somewhat less than 45°. The bark of the twigs and young shoots is smooth and shining. The bark of the trunk is coarsely ridged lengthwise.

3. **Wild Cherry or Black Cherry** (*Prunus serotina* Ehrh.). The Wild Cherry has rigid-looking stems which are flexible when bent but which break when bent sharply. The small scaly and pointed buds hug the stems closely.

FIG. 56. BEECH TWIG
Known by its slender and pointed brown buds

FIG. 57. CHESTNUT TWIG

Twigs of recent growth have ridges extending downward from the leaf scars

The broken twigs have a peculiarly pungent, bitter flavor and odor. The bark of the trunk is reddish brown and smooth when the tree is young, but scales off in thin fragments as the tree becomes older. The bark resembles that of the black birch but can be distinguished from it by the presence of conspicuous lenticels (breathing structures).

4. **American Gray Birch** (*Betula populifolia* Marsh). The twigs of the gray birch are slender and flexible. They are very tough. The new twigs are rough to the touch. The buds extend at an angle somewhat less than 45° and the twigs are bent where the buds are attached (Fig. 58). The gray birch is characterized by its sprout growth, that is, it seems to have several trunks which start out close together at the ground or near it (Fig. 59). This birch grows in very poor soil, and we associate it with scrub oaks, sumachs, barberries, red cedars and other low trees and shrubs bordering forests and occupying waste land. The white bark of the tree is chalky to the touch; it does not peel from the trunk but remains smooth as the tree grows old. There are conspicuous triangles of dark color on the trunk below the points of insertion of the branches.

Canoe, Paper or White Birch (*Betula papyrifera* Marsh) can be distinguished

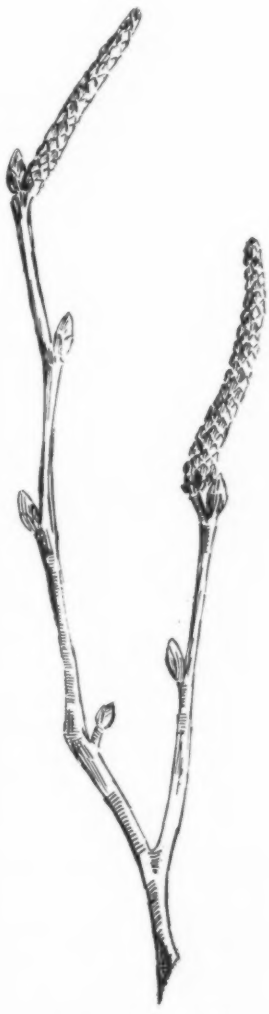

FIG. 58. GRAY BIRCH

Gray Birch twigs are rough to the touch and are bent at the points where the buds grow. Rigid, staminate catkins show their winter condition

FIG. 59. GRAY BIRCH IN WINTER

from the gray birch by the fact that the white shining bark of the trunk continually splits into thin layers and is frayed in the wind. The white birch grows to great size.

Black Birch (*Betula lenta* L.) has twigs of golden brown color and aromatic flavor,

FIG. 60. YELLOW BIRCH
The bark may be frayed into a tangle of ribbons

differing from those of the gray birch in being brittle instead of tough. The tree can be distinguished also by the bark of the trunk, which is likely to be smooth and reddish brown like that of the cherry, but lacks the horizontal lenticels of the cherry; it never frays into strips when old.

FIG. 61. WHITE ELM TWIGS

Some results of a gray squirrel's pruning. He bit off the twigs and ate the flower buds. In the spring the tree seemed in as full leaf as its neighbors

FIG. 62. BASSWOOD

Smooth and brown twigs with fat reddish brown buds

Yellow Birch (*Betula lutea* Michx.). The twigs of yellow birch are less aromatic than those of black birch. The buds are sharp-pointed, light chestnut brown and about one-fourth inch long. The bark is yellow and separates into thin pieces (Fig. 60).

5. **American or White Elm** (*Ulmus americana* L.). The twigs of the white elm (Fig. 61) are difficult of recognition. They are smooth and dark-colored, almost lacking the white spots so conspicuous on many twigs. The small brown buds are scaly and pointed. The alternate branches are given off at right and left in a horizontal plane, are about equal in length, and, although they are not quite at right angles and not opposite like those of red maple, nevertheless at first glance they give the appearance of a miniature telegraph pole with cross-bars; sprays of this character are conspicuous near the top of the tree. The white elm is easily recognized in winter by the vase shape of the tree and the delicacy of the spray.

Slippery Elm (*Ulmus fulva* Michx.) can be distinguished from the white elm by the large size and downy character of its buds and by its mucilaginous inner bark.

6. **Linden or Basswood** (*Tilia americana* L.).

The twigs are smooth and brown, not conspicuously dotted with white. The fat reddish brown buds have few scales and project from the stem at an angle of 45°. The terminal bud is often lacking. The twigs may show the bending at the points of attachment of buds as in the gray birch (Fig. 62). The bark on the trunk is dark and furrowed. The basswood sprouts

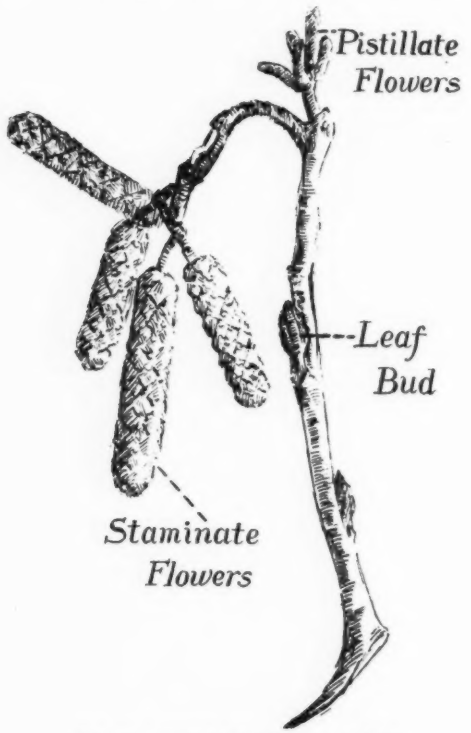

FIG. 63. TWIGS OF SMOOTH ALDER

The buds are stemmed. The drawing shows also the winter condition of staminate and pistillate flowers

out slender branches directly from the trunk.

7. **Common Alder** (*Alnus rugosa* Spreng.). The brittle twigs are grayish brown and smooth, with scattered light spots. Alder can be known by the fact that the smooth oval buds are on short stems of their own. The buds project at an angle of 45° or less (Fig. 63). This alder and the more north-

FIG. 64. WHITE HICKORY TWIG

The terminal bud is always largest. Tough, smooth twig showing conspicuous lenticels

ern species, Speckled Alder (*Alnus incana* Willd.), grow along brooks and about marshes. The twigs of the latter can be distinguished from those of the former by their downy appearance and by the large number of light-colored lenticels which give the name "Speckled" to the species. These alders seldom reach a height of more than twelve to fourteen feet.

8. **Common Locust** (*Robinia pseudacacia* L.). The recognition of locust twigs presents no difficulty. The twigs are slender, smooth and brown, ridged lengthwise and furnished with pairs of thorns. Between the individual thorns of each pair is a bud almost hidden in the center of a leaf scar: each leaf stem of the locust is hollow at its base and fits over a bud, so that no buds are visible until the leaves have fallen. The bark of the tree is rough and furrowed.

II. *Hickory and Oak: Trees with more or less stout and stiff twigs having alternate buds and dark bark.*

1. **Mockernut or White Hickory** (*Hicoria alba* Britt.). This hickory can be recognized by the large buds which are hard and round with few downy brown scales. The terminal bud is always largest; the lateral buds extend at an angle of 45° or more (Fig. 64). The tough twigs are smooth and reddish brown, and have conspicuous white lenticels. The older twigs are dark gray. The mockernut hickory is a large tree with bark showing wavy furrows.

Shagbark Hickory (*Hicoria ovata* Britt.) has buds with dark scales. The bark on the trunk "shags" off when old.

Pignut Hickory (*Hicoria glabra* Britt.) has twigs that are smooth and greenish brown; they may be somewhat angled.

2. **White Oak** (*Quercus alba* L.) can

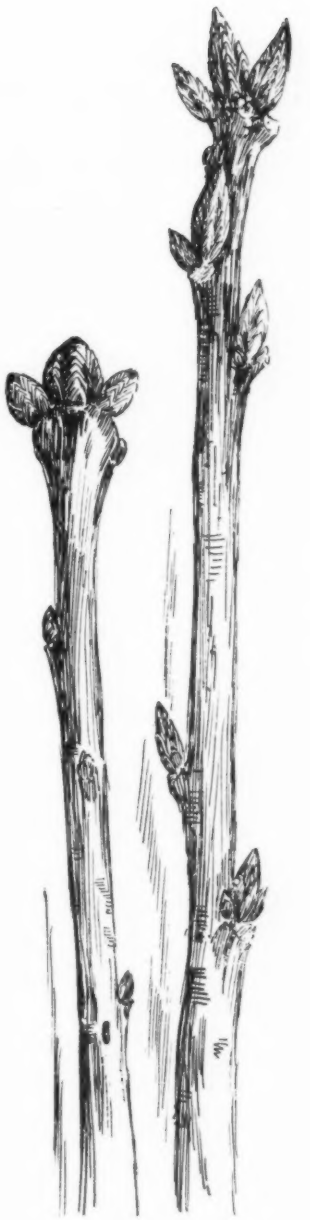

FIG. 65. OAK BUDS

Braided in appearance due to the arrangement of the scales. white oak buds are rounded; black oak, pointed.

be distinguished by its rounded buds, which have a braided appearance given by the many closely overlapping scales (Fig. 65, twig at left). Lateral buds are crowded about the terminal bud, producing a cluster. The leaf scars project from the twig. The leaves, which have rounded lobes, are likely to remain on the tree throughout the winter. The "sweet" acorns are in shallow, rough cups. The bark on the trunk of the tree is light-colored and rough.

FIG. 66. BUTTONWOOD TWIG

Conical brown buds are in the centers of the leaf scars

FIG. 67. THE TRUNK OF A YOUNG BUTTONWOOD TREE

Black Oak (*Quercus velutina* Lam.). The large buds (Fig. 65, twig at right) are sharp-pointed and somewhat downy. The twigs are smooth and have a bitter taste. The "bitter" acorns are in deep cups. The bark on the trunk is dark in color. "Oak apples" are found on black oaks.

The white oak, swamp white oak, chestnut oak, post oak and some others, are white oaks, recognized by the light bark of their trunks and the rounded lobes of their leaves. They are difficult of distinction from one another in their winter condition.

The black oak, scarlet oak, red oak, scrub oak and a few others, are black oaks known by the dark bark of their trunks and by the pointed lobes of their leaves. They also are distinguished from one another with difficulty in winter.

III. *Willow, Poplar, Buttonwood: Trees whose light-colored twigs have alternate buds and are more or less slender and flexible.*

FIG. 68. BUTTERNUT TWIG

Shows leaf buds only. The lateral leaf buds are stemmed

1. **White Willow or Golden Osier** (*Salix alba* var. *vitellina*). The twigs of this willow are light yellow in color, smooth, tough, and very flexible. The pointed buds hug the stem; each is covered by a single scale in the form of a peaked cap which may look as though empty at

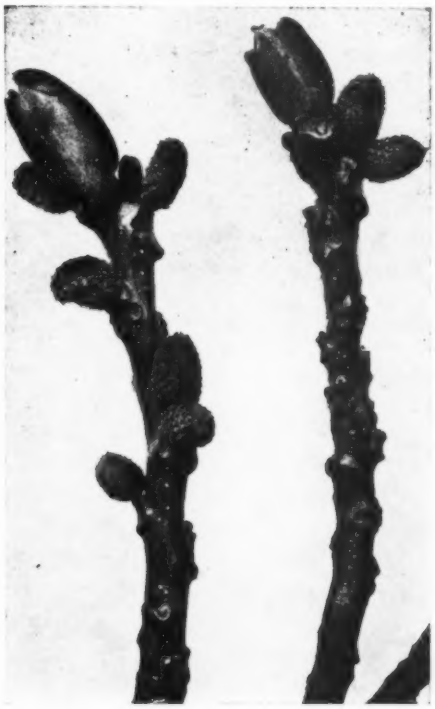

FIG. 69. BUTTERNUT TWIGS

Showing staminate flower buds

FIG. 70. BLACK WALNUT

Leaf and flower buds. The leaf scars lack the downy ridge conspicuous in butternut

the top. This tree, naturalized from Europe, is very common along streams and marshes. The many native varieties of willow are difficult of recognition even when they have flowers or leaves.

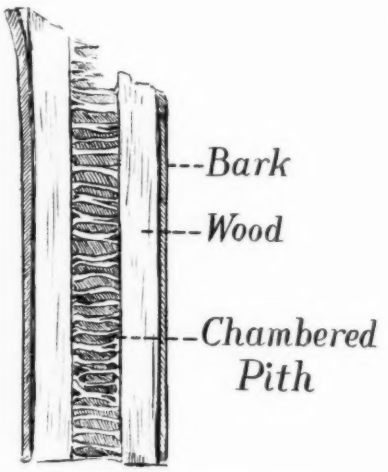

FIG. 71. BUTTERNUT TWIG

Longitudinal section to show the chambered pith

2. **American Aspen** (*Populus tremuloides* Michx.). The twigs of the American aspen are greenish gray and smooth. The pointed buds are long and covered with glossy, gummy scales. The tree is a small one with smooth greenish gray bark.

Large-toothed Aspen (*Populus grandidentata* Michx.) has the same smooth greenish gray bark as has the American aspen, but is a tree of smaller size. Its pointed buds are downy instead of smooth and they extend at right angles from the twig.

Balsam Poplar (*Populus balsamifera* L.) can be recognized by its coarse, ridged twigs and by the large sticky buds which have an unusually sweet odor.

3. **Sycamore, Plane-tree, or Buttonwood** (*Platanus occidentalis* L.). The light-colored smooth twigs are rigid in appearance. The conical brown buds are in the centers of the leaf scars, being formed within the hollow bases of stems and not showing until the leaves fall (Fig. 66). The outer board-like scale covers light-brown silky scales of great beauty. The tree can be known by the bark which comes off in plates, leaving smooth green or white spots (Fig. 67). The balls of fruit hang on the tree all winter.

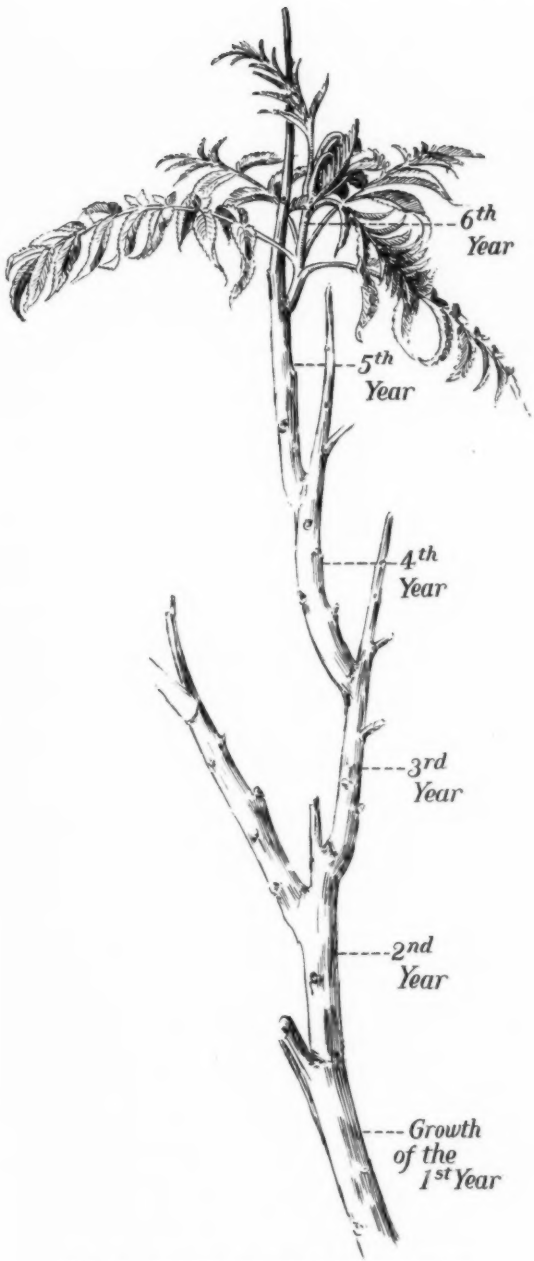

FIG. 72. GROWTH OF THE SMOOTH SUMACH
Recognized in winter by means of its tapering twigs with their dead ends

IV. *Butternut, Sumach, Poison Sumach, Ailanthus, Sassafras, Sweet Gum: Trees or shrubs with light-colored, more or less stout and rigid twigs having alternate buds.*

1. **Butternut** (*Juglans cinerea* L.) can be known in winter by its long, yellowish brown naked buds (Figs. 68 and 69). The terminal bud is much larger than the lateral buds and shows outer reduced leaves which are woolly. The lateral buds are stemmed, and have one or more smaller buds between them and their respective leaf scars. The leaf scars are large and contain three distinct U-shaped scars. Each leaf has a downy ridge above it. The pith consists of transverse chambers, between brown walls, easily seen when the twig is split lengthwise (Fig. 71). The butternut is a large tree with coarse light bark.

Black Walnut (*Juglans nigra* L.) resembles the butternut, but can be distinguished by the gray color

FIG. 73. AILANTHUS, OR TREE OF HEAVEN

Large heart-shaped leaf scars; buds small, two-scaled

of the buds and by the absence of the downy ridge above the leaf scar (Fig. 70).

2. **Scarlet or Smooth Sumach** (*Rhus glabra* L.) has light-colored, smooth stems which are straight and stiff, tapering to a more slender dead end (killed by the frost, or perhaps the remains of the fruit cluster). The buds are small and project from the centers of the leaf scars, being like those of locusts and buttonwoods in this respect.

Sumach of any variety can be recognized in winter by its spreading shape and curious tapering twigs with dead ends. The age of a sumach can be readily told at considerable distance by the curious method of branching from the one to four strongest buds (Fig. 72). The smooth sumach and the staghorn sumach (*Rhus hirta* Sudw.) carry pyramids of scarlet fruit throughout the winter, furnishing food for crows and other birds. The staghorn sumach can be distinguished from the smooth sumach by the dark velvet covering on its stems.

3. **Poison Sumach** (*Rhus vernix* L.). The grayish brown twigs of the poison sumach have extremely small buds above large reddish brown leaf scars that are conspicuously hollowed out. This sumach grows in wet places and has hanging, loose clusters of white berries, which adhere through the winter. This is the most venomous poison among our woody plants.

Poison "Ivy" or Poison "Oak" (*Rhus toxicodendron* L.) is a sumach of vine habit, either climbing fence posts, trees and the like (*Rhus radicans*), or trailing over the ground in a dense carpet (*Rhus microcarpa*).

4. **Ailanthus or Tree of Heaven** (*Ailanthus glandulosa* Desf.). The coarse and sturdy-looking but brittle ailanthus twigs (Fig. 73) have very light bark and conspicuous white

lenticels; the alternate leaf scars are large, more or less heart-shaped, and show many small scars where woody fibres broke away. The buds are small, two-scaled. The pith in the twigs is brown and extensive.

5. **Sassafras** (*Sassafras sassafras* Karst.). The yellowish green, rigid-looking twigs are arranged in bushy sprays. They are brittle and when broken give off an aromatic odor. The terminal buds, which include leaves and flowers, are prominent throughout the winter.

6. **Sweet Gum** (*Liquidambar styraciflua* L.). The young twigs are yellowish in color; the buds are reddish brown and glossy. If the twigs show the blade-like ridges of bark characteristic of sweet gum, the matter of the tree's identity is settled at once.

V. *Horsechestnut and Maples: Trees with dark-colored twigs and opposite buds.*

1. **Horsechestnut** (*Æsculus hippocastanum* L.). The dark twigs are coarse and stout, with prominent opposite leaf scars (Fig. 74). The large brown and scaly terminal buds are covered with a gummy substance. The old bark of the tree breaks away in smooth, square pieces.

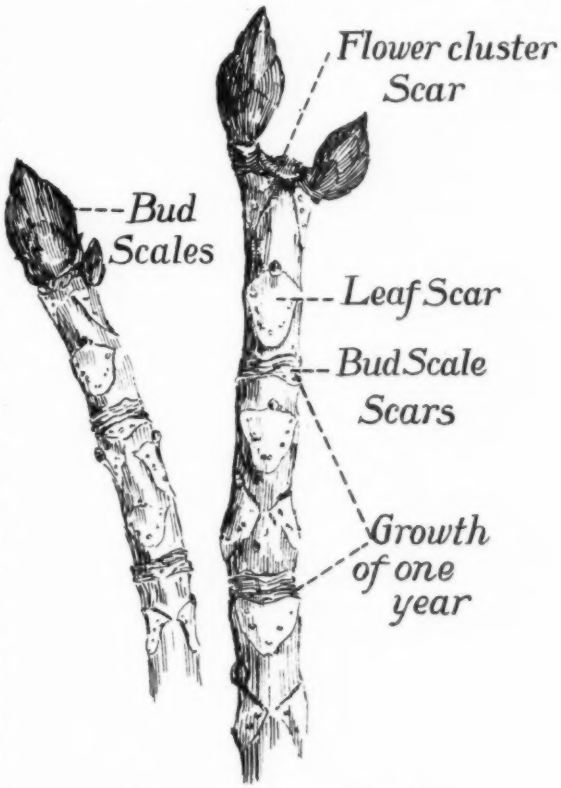

FIG. 74. HORSECHESTNUT TWIG

2. **Red Maple** (*Acer rubrum* L.). Branches, leaf scars, and buds are opposite (Figs. 75 and 76). Spherical flower buds, red in color, may be clustered around the stem adjacent to the leaf buds. Young twigs are red;

FIG. 75. LEAF BUDS OF RED MAPLE

Twigs of latest growth are red; older twigs are brown

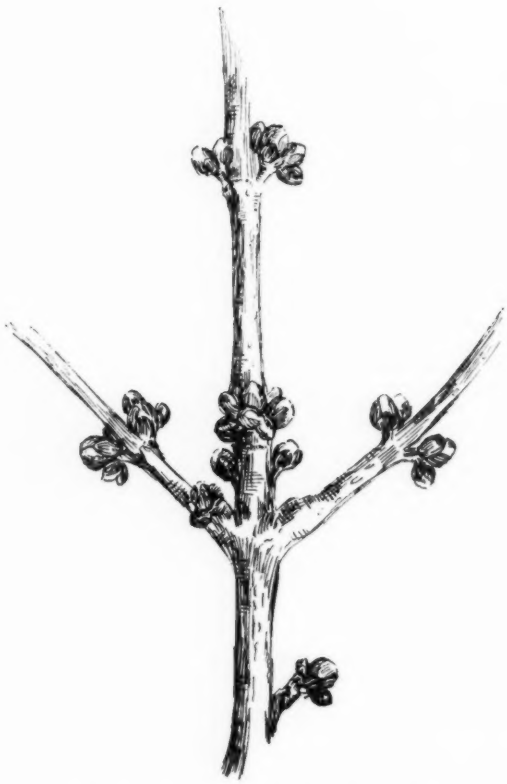

FIG. 76. FLOWER BUDS OF RED MAPLE

Branches, buds, and leaf scars are opposite

older ones, brown. The twigs are often curved like the pendulous twigs of the Silver Maple (*Acer saccharinum* L.). The old bark is smooth and gray, sometimes cracked lengthwise.

3. **Sugar Maple** (*Acer saccharum* Marsh.) has sharp-pointed and scaly brown buds. The old bark is broken into long fissures, having a "ploughed" appearance.

VI. *White Ash, Elderberry, etc.: Trees or shrubs having light-colored twigs and opposite buds.*

1. **White Ash** (*Fraxinus americana* L.). Twigs with light-colored smooth bark; branches, leaf-scars and buds opposite (Fig. 77). The ter

minal bud (rusty in color) is largest and has but few scales. The stems are flattened at the joints. The old bark is furrowed into diamond-shaped spaces.

Red Ash (*Fraxinus pennsylvanica* Marsh.) can be distinguished by the down on the new shoots. The twigs are relatively slender and are more branched than those of white ash. The buds are dark-colored.

Black Ash (*Fraxinus nigra* Marsh.) twigs are not conspicuously flattened at the joints, they have greenish bark; the buds are black in color. The tree grows in wet places.

2. **American Elder or Elderberry** (*Sambucus canadensis* L.). The opposite buds are small and nearly naked. The twigs are tapering and dead at the tips (compare with sumach, p. 95). The branching is opposite from lateral buds. The American elder seldom reaches a height greater than twelve feet.

FIG. 77. WHITE ASH TWIG

Opposite leaf scars and buds. Twig flattened at the joints

APPENDIX II

KEY TO SOME OF THE CONE-BEARING TREES OF EASTERN FORESTS AND PARKS

A. Leaves not on the tree through the winter.....Larch
(*Larix americana* Michx.)

AA. Leaves on the tree and green through the winter.

B. Leaves in bundles.

C. Leaves five in a bundle.....White Pine
CC. Leaves fewer than five in bundle. (*Pinus strobus* L.)

D. Leaves three in bundle.....Pitch Pine
(*Pinus rigida* Mill.)

DD. Leaves two in bundle.

E. Leaves 4–6 inches long.

F. Leaves flexible from long conspicuous sheathes.
Red Pine (*Pinus resinosa* Ait.)

FF. Leaves very stiff.....Austrian Pine
(*Pinus laricio* var. *austriaca* Endl.)

EE. Leaves less than two inches long.

F. Cones point outward and downward.....Scotch Pine
(*Pinus sylvestris* L.)

FF. Cones point upward.....Scrub Pine
(*Pinus banksiana* Lamb.)

BB. Leaves single in attachment to twig.

C. Leaves attached alternately all around twig.

D. Leaves extending in all directions from twig.

E. Leaves four sided, sharp pointed.

F. Leaves bluish green; cones ½ to 1½ in. long, persistent for many years.....Black Spruce
(*Picea mariana* B. S. & P.)

FF. Leaves yellowish green; cones 1 to 2 in. long, beginning to fall as soon as the scales open.....Red Spruce
(*Picea rubens* Sarg.)

EE. Leaves flat, blunt.....Fir Balsam (young branch)
(*Abies balsamea* Mill.)

DD. Leaves spreading at sides of twig in two ranks.

E. Leaves along top of twig minute.....Hemlock
(*Tsuga canadensis* Carr.)

EE. Leaves along top of twig not reduced in size.
Fir Balsam (old branch) (*Abies balsamea* Mill.)

CC. Leaves attached opposite each other or in whorls closely covering the twig.

D. Spray flat.

E. Cones opening to the base at maturity; scales thin.
Arborvitæ (*Thuya occidentalis* L.)

EE. Cones never opening to the base; scales thick and beaked.
White Cedar (*Chamæcyparis thyoides* Britt.)

DD. Spray 4-angled.....Red Cedar
(*Juniperus virginiana* L.)

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